Birds in Wales

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Editorial

If there is a theme to this issue of Birds in Wales, it is of monitoring species which are or may be in decline in Wales. The 2011 issue included a paper by Julian Driver giving the results of his comprehensive census of the Ring Ouzel population of Snowdonia. This year he has produced a paper showing population trends in the core breeding area here since 2009. The results are encouraging, with the overall population in this area shown to be stable, in contrast to declines in some other areas of Wales. Another species of considerable concern is the Whinchat, and this is covered in the paper by Ian Henderson, David Noble and Kelvin Jones on the chat survey in Wales in 2012 and 2013. A repeat of this survey a few years from now could provide very valuable information on population trends, particularly in view of comments from several observers that Wheatears seem to have been less numerous in some of their regular breeding areas this year than previously.

The Pied Flycatcher is a species which is in long-term decline, partly because numbers of its insect prey are now peaking earlier, and the birds are arriving on their breeding grounds too late to take full advantage. The paper by Cathryn Tyrrell in this issue introduces what is likely to become a very important method of investigating diet, the molecular analysis of digestive tract samples. Two species of tit are also of great conservation concern in Wales, the Marsh Tit and the Willow Tit. The Willow Tit, in particular, has been lost from many areas of Wales. We include here a paper by Ian Morris on the population of these two species in an area of south-east Ceredigion where both species are still to be found.

Among the species of conservation concern in Wales are several breeding wader species which have declined markedly over the past fifty years. The paper by Ian Hawkins on the Morfa Madryn reserve on the north coast describes the management of a small reserve which holds a very important population of breeding Lapwing as well as smaller populations of other waders. The paper by Reg Thorpe and Anne Brenchley on the promotion of bird surveys and monitoring in Wales identifies a number of priority species for monitoring efforts in Wales, including several of those mentioned above. The highest priority is given to Lesser Spotted Woodpecker and Merlin. Finally, a short paper by Reg Thorpe and Adrienne Stratford introduces the first edition of the Welsh List, which can be seen in full on the WOS website.

There remain many gaps in our knowledge of the numbers, distribution and population trends of various species in Wales. I hope that the papers here will inspire more observers to help fill these gaps, by getting out in the field to conduct surveys and then publishing the results.

Thanks to Dave Smith, Ian Johnstone, Anne Brenchley, Geoff Gibbs and Mick Green for acting as referees. I thank Ian Spence for his help with the layout of this and previous issues of our journal. Thanks to Kelvin Jones for taking responsibility for the photographs, and to the photographers, credited individually for each photograph, for permission to use their work.

Rhion Pritchard

Ring Ouzels (*Turdus torquatus*) in Snowdonia, 2009-16

Julian Driver
Hafod y Fedwen, Gwyllt Road, Llanfairfechan, North Wales, Ll33 0EG

Crynodeb

Cofnodwyd dosbarthiad a thiriogaethau Mwyalchen y Mynydd o fewn y tair prif ardal nythu ym mynyddoedd Eryri dros gyfnod o wyth mlynedd, 2009-16. Nodwyd lleihad sylweddol yn y boblogaeth mewn rhai mannau eraill yng Nghymru, ond dangoswyd fod y boblogaeth yma yn aros yn gyson gyda thua 102 o barau. Er hynny, roedd amrywiaethau lleol sylweddol yn nifer y tiriogaethau, ond nid oedd hyn yn effeithio ar y boblogaeth yn gyffredinol. Casglwyd ychydig o ddata am nythu hefyd, sy'n awgrymu fod cynhyrchiant yn dda, ar sail y nifer dda o gywion sy'n magu plu.

Summary

The distribution and territorial occupancy of breeding Ring Ouzels within three core breeding areas of the Snowdonia mountains, North Wales, were recorded over an eight year period, 2009-16 and despite considerable population declines noted elsewhere in Wales, this population was found to be stable at about 102 pairs. There were, however, considerable localised annual fluctuations in territorial occupancy, but this did not impact on the overall population. A small amount of breeding data was also collected and this suggested that productivity was good based on the high number of fledged broods.

Introduction

In response to numerous reports of a widespread decline in the UK Ring Ouzel population, in 2009 I engaged upon a long term population study of those Ouzels that inhabit the mountains of northern Snowdonia, the initial results of which have already been summarised (Driver 2011). This latest update presents breeding data collected over eight years 2009-16 focusing on the population and territorial occupancy within three contiguous mountain massifs of Carneddau, Glyderau and Snowdon that make up the core breeding range of Ouzels in Snowdonia (Fig 1). Being the most intensely worked regions they provide the best means for detecting long term population trends and enable close monitoring of territorial occupancy. A small amount of nest data was also collected, though locating and monitoring nests was of low priority.

Method

The census method was as previously described (Driver 2011) and relies on locating and mapping occupied territories throughout the designated study area. This is quite different from the methods used in other large scale UK Ouzel surveys that employ walking transects in selected tetrads and broadcasting taped Ouzel song. Such playback of song was not used in this survey. Intensive daily coverage was divided as evenly as possible between the three core regions and maintained throughout the breeding season with just occasional breaks, usually due to poor weather. Even so

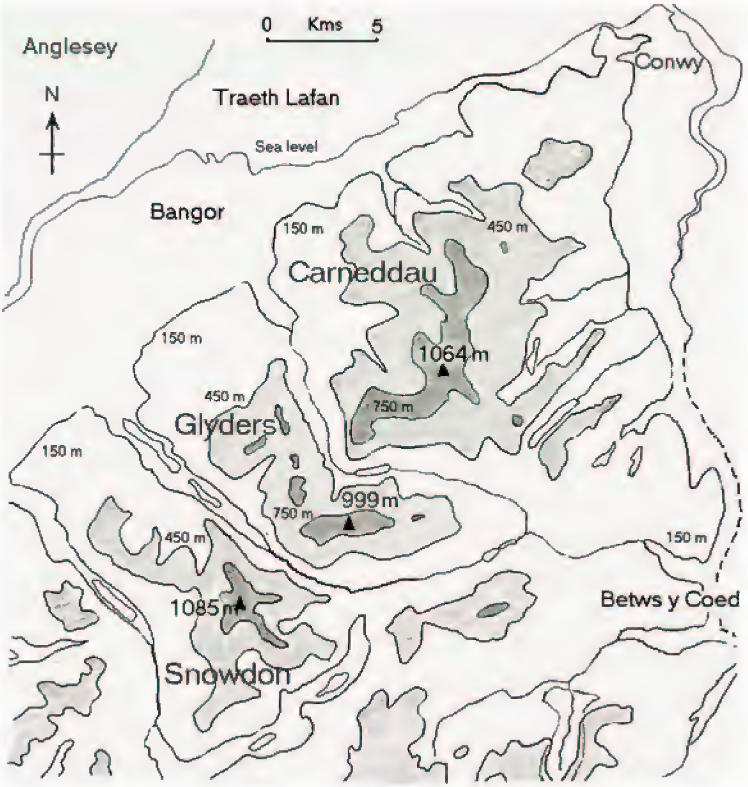

Figure 1. Relief map of the study area.

it is unavoidable that some bias towards monitoring those areas with a proven history of breeding Ouzels was likely. The basic unit of 'territory' is used here as a convenient term to identify specific sites where proven or probable breeding was established by repeated observations of agitated behaviour, singing, territorial conflict, occupied nests or recently fledged young. Initially, undertaking an accurate survey by this method seemed a daunting task but with previous knowledge of territorial distribution and considerable experience of negotiating the mountainous terrain, this survey method proved quite feasible and was carried out alongside other montane ornithological and bryological fieldwork.

Population size and Territorial occupancy

Within those core regions, an annual average of 102 Ouzel territories (range 92-110) were located over eight years 2009-16. The Carneddau, the largest of these massifs, held an annual average of 50 (range 48-52) territories followed by the slightly smaller massifs of the Glyderau with an average of 28 (range 21-31) and Snowdon with an average of 24 (range 20-28) territories (Table 1).

Regions	**Years, 2009-16**								
	09	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**Average**
Carneddau	49	50	48	51	52	52	49	51	50
Glyderau	26	30	29	31	31	30	22	21	28
Snowdon	20	22	24	28	26	27	21	23	24
Total	**95**	**102**	**101**	**110**	**109**	**109**	**92**	**95**	**102**

Table 1. Annual number of occupied territories within core breeding areas of Snowdonia, 2009-16.

Considerable fluctuation in annual territorial occupancy was noted (Table 2). A substantial number, 54, were occupied for only a single season, possibly late nesters or pairs relocating for their second nesting attempts. Of the more regular territories 110 (52%) were occupied for 2-5 seasons and 49 (23%) for 6-8 seasons; 18 of these were occupied in all eight years (Table 2). There were indications that levels of occupancy might be linked to territory quality, with those in what appeared to be the least suitable habitat occupied for much shorter periods or only sporadically. Of the latter, 37 territories were left vacant for periods of 2 to 6 successive years (average 3 years) before being reoccupied, presumably by different birds.

Region	**Number of years of occupancy**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Carneddau	24	9	15	9	11	8	11	10
Glyderau	16	10	6	11	4	1	4	7
Snowdon	14	13	9	7	6	2	5	1
Total territories	**54**	**32**	**30**	**27**	**21**	**11**	**20**	**18**

Table 2. Number of years of territorial occupancy, 2009-16

Ouzels in Snowdonia typically breed in localised areas, particularly where there is prime habitat (see below) and this is a prominent feature of the distribution map (Fig. 2). Substantial annual fluctuations can occur within these local clusters. A few representative examples are presented here (Table 3) with locations marked A-Y on the distribution map (Fig 2). In some cases such fluctuations are probably due to new pairs establishing temporary territories in peripheral positions e.g. an additional 2-3 pairs took up territories on Yr Ole Wen but only for two seasons 2013-14 after which the sites were abandoned. The variations in the figures also suggest that within the entire population there may be considerable nomadic movement. For example, in the Anafon Valley numbers increased from 2 to 6 pairs over eight years whereas in the Llyn Cowlyd area numbers declined from 10 to 3 territories over the same period.

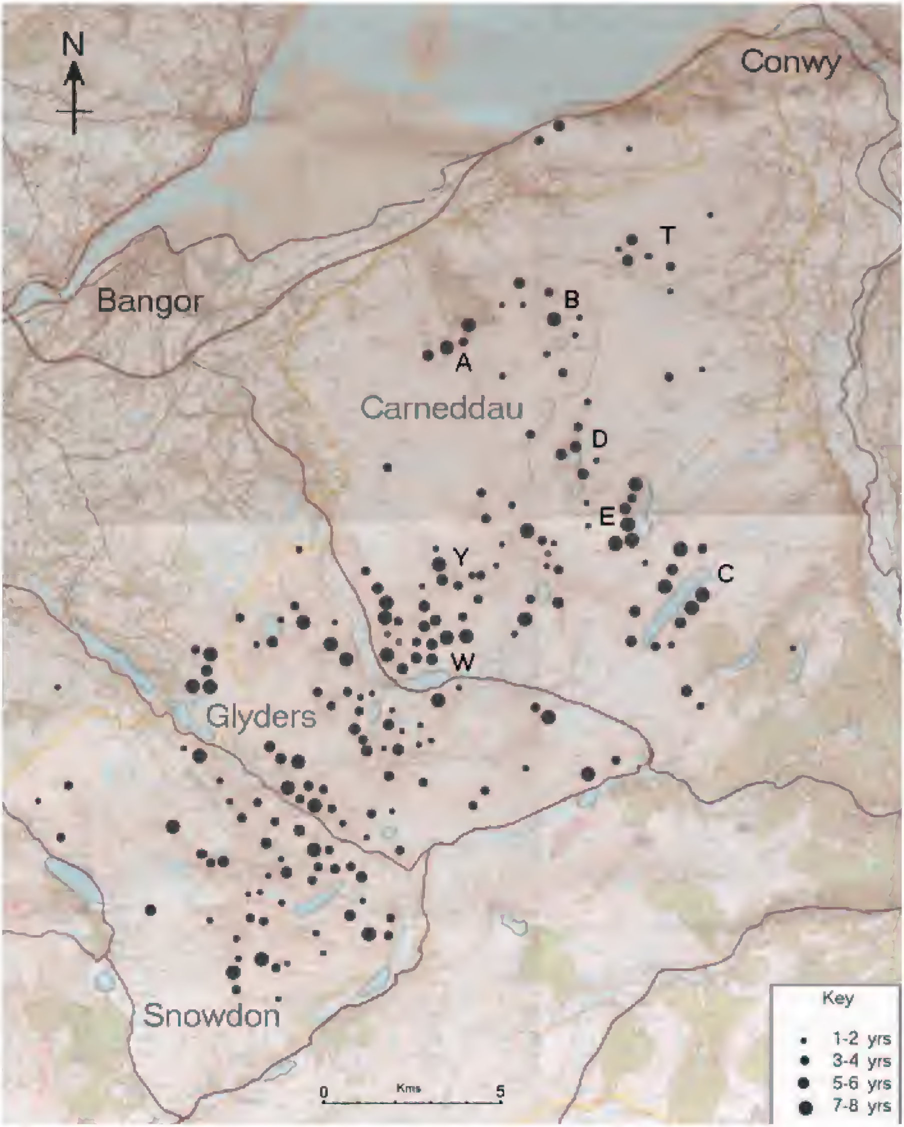

Figure 2. Cumulative territorial distribution map indicating the number of years of occupancy, 2009-16. Letters A, B, C, D, E, T, W, Y indicate specific locations (see table 3).

Locations	Map	Alt. Range (m)	Years 2009 -2016							
			09	10	11	12	13	14	15	16
Aber Falls	A	300-450	2	3	4	4	4	3	3	2
Anafon Valley	B	350-650	2	2	3	4	3	3	4	6
Llyn Cowlyd	C	400-650	9	10	10	8	8	7	4	3
Cwm Dulyn	D	500-700	2	2	1	3	3	3	2	3
Craig Eigiau	E	450-550	3	4	4	5	5	6	6	5
Tal y Fan	T	400-540	2	4	3	4	3	1	2	3
Yr Ole Wen	W	400-800	5	4	4	5	7	8	5	5
Ysgolion Duon	Y	550-950	2	1	2	2	3	3	4	3
			27	**30**	**31**	**35**	**36**	**34**	**30**	**30**

Table 3. Annual number of occupied territories within some specific areas of the Carneddau massif, 2009-16

Breeding data

As mentioned above, no special effort was made to locate nests and the 39 that were found, were usually discovered by chance. Nonetheless, the figures do provide some indication of the breeding performance of Ouzels in the mountainous terrain of Snowdonia. Most nests were located in deep rock crevices on high vegetated cliffs with copious amounts of Heather or Bilberry and adjacent grazed sheep-walk, that was considered to be prime habitat. On two occasions occupied nests were found at ground level amongst rocks on steep boulder slopes below the high summits of Carnedd Dafydd and Elidir Fawr. Double broods or repeat nesting attempts were quite frequent, with first clutches usually occurring during the first half of May followed by second nesting attempts in early June (Table 4). The earliest clutch was on 24th April and the latest on 13th June. The latest nest containing chicks was found on 11th July but a recently fledged late chick was disturbed from the immediate vicinity of an empty nest on the 21st July.

Periods of egg laying	24th to 30th April	1st to 15th May	16th to 31st May	1st to 13th June
Number of clutches	3	12	4	7

Table 4. Approximate egg laying dates at 26 nests (*estimated from incomplete clutches or back-dating from known hatching dates*).

Of 21 good nest histories, 17 nests held clutches of 4 eggs (range 3 to 5), averaging 3.9 eggs per nest, and 12 nests had broods of 4 chicks (range 2 to 4) averaging 3.45 chicks per nest (Table 5).

Clutch size	Number of clutches	Brood size	Number of broods
2	-	2	2
3	3	3	7
4	17	4	12
5	1	5	-
	3.90 eggs per clutch		**3.45 chicks per brood**

Table 5. Clutch and brood sizes for 21 nest histories

Fledging success could rarely be determined, but of six nests with chicks close to fledging, four would each have produced 4 young and two others 3 young, averaging 3.7 fledged young per successful nest. Despite this shortage of fledging data, productivity was considered to be substantial, based on numerous encounters with fledged young of various ages. There was just one occasion when a complete nest cycle was recorded from 1st egg to fledging, a period of 32 days, and slightly longer than the 28 days (26-30) stated in most text books (Cramp 1988). This could, however, have been a consequence of observer disturbance during the egg laying period causing interrupted incubation. At least 5 nests were known to have failed, mostly at the early chick stage, with clear evidence of predation, i.e. nests found dislodged or badly damaged, suggesting Raven (*Corvus corax*) or Carrion Crow (*Corvus corone*) to be the most likely culprits. However, Stoat (*Mustela ermine*) also inhabit these mountain slopes and on two occasions were observed predating Wheatear (*Oenanthe oenanthe*) nests so must also pose a risk to nesting Ring Ouzels.

Conclusions

The most outstanding result of this study has been the considerable annual fluctuation noted amongst localised clusters often located in isolated cwms or valleys. This is perhaps not unexpected for such a mobile and somewhat nomadic montane species, and it is surprising that such behaviour has not been emphasised in other Ouzel studies. However, despite such instabilities a good proportion of territories were occupied repeatedly over several seasons, illustrating just how site faithful they can be when breeding in prime locations. In Glen Clunie, Scotland a colour ringed male is reported to have returned to the same nest site for eight years running and during that time had acquired five different mates (Ring Ouzel Study Group 2016). It is therefore reasonable to assume that many of the long term Snowdonia nest sites will also have been occupied by the same returning individuals, though other sites will no doubt have been occupied by a succession of different birds. Such was the case at one particular site in the Anafon Valley near my home which has been occupied almost continuously since at least 1986 with just occasional blank seasons.

These results clearly show that the Ring Ouzel population in Snowdonia has remained reasonably stable; a conclusion also confirmed by my 40 years of casual observations. During that time I have not detected any obvious population changes, nor noticed any contraction in range. This is contrary to surveys in other parts of Wales that report significant long term declines with contraction in breeding range (Green 2007, Smith 2014, Sim et al. 2010).

Undertaking a large scale census in such challenging terrain posed many difficulties and it is inevitable that a few occupied sites will undoubtedly have slipped through the net. The field work required considerable sweat and toil often in difficult weather conditions but, from a personal perspective, the sheer joy of working the mountains and wild places was sufficient motivation to overcome such physical challenges. Eight years may be insufficient time for such a study, but the data so far collected does provide a short-term indicator of the current breeding status of Ring Ouzels in this part of Wales.

Acknowledgements

I am indebted to Peter Dare who made available many published papers on Ring Ouzels in Britain as well as making many useful suggestions to improve the draft paper. I am also thankful to David Smith who acted as a referee and also provided many helpful comments.

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Population estimates and habitat associations for Stonechat (*Saxicola rubicola*), Whinchat (*Saxicola rubetra*) and Wheatear (*Oenanthe oenanthe*) in Wales, 2012 and 2013

Ian Henderson, David Noble and Kelvin Jones
British Trust for Ornithology, The Nunnery, Thetford, Norfolk IP24 2PU, UK

Crynodeb

Yn 2012 a 2013, cynhaliwyd arolwg o Glochdar y Cerrig, Crec yr Eithin a Thinwen y Garn dros Gymru, gyda samplo cynrychiadol haenedig ar sail chwe chategori eang o ddosbarthiad tir. Ar sail dau ymweliad a'r sgwariau 1-km dynodedig, cofnodwyd adar a chynefin ar ddwy raddfa a) 1-km a b) o fewn 25m i gofnod o aderyn. Roedd dulliau safonedig a diffiniedig yr arolwg yn caniatáu dadansoddiad o uniadau cynefin gwrthrychol ac amcangyfrif poblogaeth, er bod lwfiadau gwallau llydan ar gyfer yr ail. O ran cynefin, y gwahaniaethau mwyaf dadlennol oedd rhwng Clochdar y Cerrig (sychach) a Chrec yr Eithin (gwlypach), yng ngoleuni'r newidiadau gwahanol ym mhoblogaeth y rhywogaethau hyn ac effaith bosibl newid hinsawdd ar ben dulliau rheoli glaswelltir. Ar gyfer Crec yr Eithin yn arbennig, efallai fod cynefin nythu addas yn prinhau ac yn dod yn fwy darniog o ran maint a chaffaeladwyedd. Trafodir amcangyfrifon poblogaeth ar gyfer Cymru gyda dehongliad.

Summary

In 2012 and 2013 a survey of Stonechat, Whinchat and Wheatear was conducted across Wales with representative sampling stratified according to six broad land-class categories. Based on two site visits to allocated 1-km squares, bird registrations and habitat were recorded at two spatial scales a) 1-km and b) within 25m of a bird registration. The standardised and defined survey procedure allowed objective habitat associations to be analysed and population estimates to be calculated, the latter albeit with broad error margins. In terms of habitat, contrasts between Stonechat (drier) and Whinchat (wetter) were most revealing given the context of diverging population change in these species and potential influences of climate change on top of grassland land management. For Whinchats in particular, suitable breeding habitat may be becoming more restricted and fragmented in extent and availability. Population estimates for Wales are discussed with interpretation.

Introduction

The three open-country chats, Wheatear, Whinchat and Stonechat, have different life cycle characteristics that combined cover both long-distance and partial migration, and that fall under the conservation spotlight for contrasting population trends (Vickery et al. 2014). Stonechat is a short–distance, partial migrant species that has undergone a pattern of long-term population increase in Britain (Balmer et al. 2013; Harris et al. 2016). The Wheatear and Whinchat are two long-distance migrants, whose population trends in Britain have declined in the last 40 years, and, for Whinchat especially, during the last 25 years (Balmer et al. 2013; Harris et al. 2016). While there are indications that the contrast in trends may be due to factors affecting post-breeding survival (Okenden et al. 2012; Henderson et al. 2014), there are also well-documented accounts of long-term changes to grassland breeding habitats for Wheatear and especially Whinchat (Henderson and Fuller 2004; Calladine and Bray 2012), that suggest that the availability of breeding habitat may be an issue too.

The chats, historically, have received relatively little conservation attention, for example, as recently as 2005 Whinchat was considered a 'green' species of conservation concern. Despite widespread reports of a decline, however, Wales still remains a relative stronghold for both breeding Whinchat and Wheatear in the UK (Balmer et al. 2013), which suggests that core elements of their preferred habitat probably still persist in Wales. This supposition provided the rationale for a dedicated breeding season survey of all three species in Wales during 2012 and 2013. Primarily the purpose of the survey was to improve the surveillance and monitoring of the status of these species in remote landscapes, for future reference, but also to identify key and contrasting habitat characteristics associated with these populations, and to raise subjects for further study.

Methods

The survey stratification framework used six broad, amalgamated land-class types (from the ITE 2000 Countryside Survey: Bunce et al. 2007 and Land-cover data: Fuller et al. 2002; Table 1a) that together covered the majority of Wales. Priority was given to those land-classes that were most likely to hold breeding chats but the survey also sampled other habitats that potentially could have held a large proportion of chats but at low density. The survey included areas of the Welsh uplands that are generally less well covered by annual breeding bird monitoring in the UK, and the habitat was surveyed at a finer resolution than is done routinely within monitoring work (Balmer et al. 2013; Harris et al. 2016).

Survey squares were visited twice, between mid-April and mid-July, with the observer attempting to cover all accessible areas of the square to within 200 metres distance, noting any areas that were either inaccessible or un-viewable. They mapped the locations of all bird sightings along with details of group size, sex and age, and the birds' activity (perched, singing, flying, carrying food). Observers recorded the presence of 14 pre-defined habitat categories (see Table 1b) within a 25m radius of each chat registration, and in addition they made a whole square assessment, by eye, designed to confirm the presence or absence of relevant habitats, even where no birds were seen (also ensuring the return of zero-count data). Further information on the content of the squares was taken from the national data sets that class every 1-km square on the basis of: a) a single dominant land-class category (called 'Land-class') or b) by the percentage cover of different land categories (called 'Land-cover').

An analysis of habitats (using General Linear Modelling regression) was conducted at two levels (1-km and 25m scales), to relate bird occupancy to both habitat features collected by field observers and both of the independent datasets, Land-class and Land-cover. The counts also allowed us to calculate broad mean estimates of population size (with 95% confidence intervals), by extrapolation, according to the proportional cover of the survey within each land-class category and the proportional cover of each land-class category within Wales. The basis on which a bird registration was included in the population estimates is summarized in Table 2. Broadly, the estimates used the following criteria: i) a nest site being present, ii) parents carrying food, iii) a pair being present, iv) singing individuals, and v) a family group or juveniles being present.

Land-class title	**Definition**	**Percent of 1-km squares in Wales belonging to each land-class category**	**Priority habitat for survey?**
Coastal	Coastal cliffs, slopes, estuaries, dunes, marshes; usually arable or pastoral, landward though some heathland.	8	Yes
Intensive	Level, alluvial or open countryside, few hedges, trees; intensive agriculture, including arable.	16	
Improved	Rolling, undulating pastoral, hedges, small amounts of arable	25	
Mixed	Valleys of mixed arable & pastoral, often hedges, fences.	5	
Marginal	Undulating moderate relief, mainly unenclosed pastoral, few hedges.	41	Yes
Upland	Broad rounded hills, Calluna, Nardus, open, few trees.	4	Yes
Land-cover variables (LCM2000) are estimate, by satellite, as the percentage cover of a 1-km square of habitat categories. In this case six broad categories were used including: Coast, Arable, Improved grass, Semi-natural grass, 'Moor/heather/bracken', Conifer Woodland.			

Table 1a. Broad amalgamations of ITE land-classes were used as categories of convenience for stratifying, sorting and allocating survey squares. They were not used as definitive habitat types.

Heather, Bilberry, Bracken
Other herbage >0.5m (umbellifers (Apiaceae), docks, tall stalks projecting above sward)
Short grassland <20cm
Uniform grassland ('improved' grassland, mown or grazed)
Tall grassland
Uneven grassland ('tussocky', 'unimproved', rough pasture, or uneven upland grass
Damp habitats (wet flushes, rushes, lusher vegetation, bogs, streams, flood meadows and salt
Animal burrows, dry stone walls, ruined buildings, rock outcrops (including cliffs and scree)
Shrubs <2m; 10) Shrubs >2m and/or trees
Young plantations <2m
Hedgerows
Linear features (grassy verges, field margins)
Arable crops
Apparent public activity on foot (recreation, picnicking, dog walking, etc.)

Table 1b. The 14 habitat categories allocated by observers to within 25m of birds observations and then also applied as a general assessment to survey squares by observers.

Activity	Decision	Reasoning
Visiting nest	Pair = 1	
Carrying food & count = 1, 2 or 3	Pair = 1	Conservatively, i.e., one bird carrying food with one or two others present.
Male & female dual count	Pair =1	But if count >3 then pair =2 maximum. This limited potentially false allocations of territory status among mixed groups of males and females, as may occur on passage. In practice, applicable to Wheatear only.
Juveniles present	Pair = 1	In practice, counts suggested only one pair per observation.
Singing heard	Pair = 1	Such counts exceeding 2 were rare.
Mixed activity	Pair = count/2	These observations were relatively rare (mainly Wheatear) and mainly of two to five individuals with some indications of territorial behaviour within the group.
Breeding status not recorded	Two alternatives were possible, i) where a pair = the count, (maximum estimate), and, ii) where such individuals were considered as transients and pair present =0 (minimum estimate). The true value will lie somewhere in between.	

Table 2. Criteria used for assigning 'pair' or territory status to observations.

Results

Survey coverage

The survey managed to cover 192 and 104 1-km squares in 2012 and 2013 respectively (approximately 1% of non-urban 1-km squares), with chats being recorded in 63% of squares (Wheatear 1,430 observations, 52.2% of squares, Stonechat 772 observations, 39.0% of squares and Whinchat 92 observations from 10.2% of squares).

Habitat associations

At the 25m patch scale at which birds were actually observed, Stonechats were associated with a broader and coarser mix of herbaceous cover, bracken, heather or shrubs but Whinchats were more strongly associated with bracken and heather only (Table 3). Interestingly, at the larger 1-km scale bracken was not a dominant feature of the landscape for Whinchats, and there was a mixed relationship with heather moorland suggesting an association with mosaics rather than blanket coverage. Importantly, Whinchats were less prevalent in landscapes dominated by short uniform grassland than in squares comprising a higher proportion of semi-natural grassland, plus a strong association with damp habitats and, to a lesser extent, plantations. Stonechats by comparison were not recorded in association with damp habitats or plantations but as expected had a much stronger coastal distribution than Whinchats.

	Stonechat	Whinchat	Wheatear
Within 25 m of a bird registration:			
Heather	++	+	
Bracken	+++	++	--
Other herbage	+++		--
Short, uniform grassland	---		+++
Uneven grassland			+++
Shrubs	+++		---
Hedgerows	-		
Rock outcrops			+++
Within the 1 km survey square:			
Heather		-	
Bracken		-	
Other herbage			
Short, uniform grassland		---	
Uneven grassland			
Damp habitats	-	+++	
Shrubs			
Young plantation	--	+	
Arable			-
Relationship to 1-km square land-class categories:			
Coastal	+++	-	
Improved (mainly pasture)	-		
Intensive (mainly arable)			-
Mixed			
Marginal	++	+	
Upland			
Relationship to % land-cover categories:			
Coast	++		
Moor/heather/bracken		+++	+
Conifer Woodland		+	
Semi-natural grass	--	+	---
Improved grass			
Arable			-

Table 3. A summary of an analysis of Stonechat, Whinchat and Wheatear registrations in relation to habitat and landscape. Significant relationships (either positive '+' or negative '-') are as follows: +++ or --- ($P < 0.001$), ++ or -- ($P < 0.01$), + or - ($P < 0.05$).

Wheatear, as expected, avoided all structured, herbaceous elements of habitat in favour of grassland, whether grazed or uneven. Interestingly Wheatears either avoided or were less detectable in large areas of semi-natural grassland cover, possibly due to its taller structure. There was also an expected association with rocky outcrops, where the species will both nest and appear more in view.

Population estimates

Population estimates for the three species are presented in Table 4, alongside estimates from previous years. For 2012-13, formal error margins are presented, and are wide. Unfortunately comparable error margins could not be calculated for previous estimates because the survey methods used were not randomised, stratified or standardised. Thus, for Whinchat in 2012-13, the estimate is just under 3,000 pairs. There were only 92 individual registrations, so zero counts were high, contributing to the wide error margins. For Stonechat, our best estimate lies between 9,736 and 14,448 pairs. For Wheatear, our best estimate is around 13,000 pairs. Both Stonechat and Wheatear were quite commonly encountered, but breeding status was especially hard to verify in Wheatears, and encounters were often aggregated, contributing to wide margins of error.

	Lovegrove et al. 1994: 1994 estimate	**Green 2002: 2000 estimate**	**Present study: 2013 mean estimate**	**Present study: 95% confidence estimates**
Whinchat	5,000-6,000	2,400	2,825	1,046 – 6,027
Stonechat	No estimate	3,000-3,500	12,082	5,173 –22,926
Wheatear	3,500-4,500	5,000-10,000	13,759	7,153 – 25,861

Table 4. Population estimates (pairs).

Discussion

In this survey, we generated some basic associations between species and habitats or landscape characteristics. Relationships for Wales are consistent with our general knowledge of the species' natural history, but components underpin the growing consensus that land management has contributed to a squeeze on niche availability for Whinchat in particular (Calladine and Bray 2014). Conservation wise, Whinchat deserves the most urgent attention due to a rapid population decline, even in this apparent stronghold in Wales. Key characteristics of breeding habitat were consistent with the grassland and vegetation structural variation found elsewhere. Whinchats require suitable perches from which to forage or display (e.g. tall flower stems, bracken, light scrub or small trees), by short swards, and tussocks in which to nest safely and forage (Border et al. 2016, Murray et al. 2016). Such qualities are now mostly retained within marginal and transitional habitats, such as wet areas or ffridd, that exist due to circumstances of topography, water logging or fencing (around young plantations), to limit habitat homogenisation through grazing or management (Fuller et al. 2006). An association with damp features for Whinchat is consistent with this species' tendency to select an insect rich, temperate micro-climate in Europe, including lowland wet meadows in Slovenia (Tome and Denac 2012), meadow slopes in Switzerland (Müller et al. 2005) and lower grassy valley slopes on Salisbury Plain, that are wet in winter but lush in summer (Border et al. 2016). In upland boggy habitats, drying, through drainage management and climate warming, can significantly reduce the abundance of important prey species, such as crane flies, for species such as Whinchat (Carroll et al. 2011, Pearce-Higgins 2011).

Stonechats by comparison, are short distance migrants that in Europe can thrive in drier breeding conditions than Whinchats, including Mediterranean habitats and lowland heathlands where breeding Whinchats are rare (Hagameir and Blair 1997). The species appears to be better adapted to benefit from relaxed thermal limitations, which improves survival rates and opens up new habitat opportunities (Jiguet et al. 2009). This has undoubtedly contributed to range expansion in Wales and the UK generally. Whinchats, by comparison, with a relatively short breeding window, rely on predictable, high-season prey abundance. As long distance migrants, they are more susceptible than Stonechats to a disruption in the timing of peak prey availability (Visser et al. 2015). These contrasting ecological requirements between the two species offer a likely explanation for their diverging population trends (Juiget et al. 2007), via differences in survival rates and/or productivity. The survey also allowed population estimates to be formally estimated for Wales for the first time, and in spite of wide margins of error, population estimates are calculated using a standardised survey protocol that is defined and repeatable. Earlier estimates appear to be based on densities or occupancy rates calculated at varying scales, so the decisions used for extrapolation are unclear, but probably involve expert judgement. This means current and past estimates are difficult to compare.

For Whinchat, Lovegrove et al. (1994) estimated 5,000-6,000 pairs for 1994. The BBS trend for 1995-2012 was -53%, which following Lovegrove et al (1994) would suggest around 2,500-3,000 pairs for 2012. Independently, the British population estimate was 46,864 in 2009 (range: 18,689-75,000 pairs) also based on the BBS (Musgrove et al. 2013), and the Welsh proportion of the atlas (Balmer et al. 2013) for Whinchat was around 10% in terms of occupied squares, or 4,900 pairs. However, the British estimate was simply calculated from the number of individuals, halved, which potentially overestimates true territory occupancy. Since 2009, the rate of decline in Whinchats in Britain has slowed (Harris et al. 2016), therefore, again, our current mid-estimate for Wales of perhaps 3,000 pairs seems reasonable. Against this rationale, the Green (2002) estimate of 2,400 pairs for year 2000 appears low.

For Stonechat there have been rapid, weather-related, fluctuations in population status, though principally increasing by around 250% between 1995 and 2012 (Risely et al. 2012). Detectability is far less of an issue for this species than for Whinchat, and it is more likely to occur in widely scattered territories at low density, potentially on sub-optimal land. Our estimate using representation across landscape types lies between 9,736 and 14,448 pairs (95% confidence range: 7,342–22,925). Green (2002) suggested 3,000-3,500 pairs (year 2000), based on the national atlas survey 10 years earlier (Gibbons et al. 1993), though in fact the species was increasing in the intervening years, and indeed the BBS trend for 1995-2014 was a significant 93% (Harris et al. 2016), almost double. The BBS may also under-represent change in remote regions of Wales where the species has increased most (Balmer et al. 2013). The estimate for Britain in 2009 was 56,000 pairs (Musgrove et al. 2013), with the Welsh contribution being around 20% of occupied squares (Newson pers. comm.) suggesting 11,200 pairs. The 9,000 to 14,000 pairs range for Wales therefore seems reasonable.

Wheatear was difficult to survey accurately using a multi-species, approach, in terms of survey timing and not knowing where to ‘draw the line’ in terms of defining passage versus breeding status. Wheatear has a protracted migration, which increases the risk of breeding status being assigned to birds that are still on passage, even in May, and particularly on the coast. Lovegrove et al. (1994)

and Green (2002) provided very different estimates of 3,500-4,500 pairs and 5,000-10,000 pairs respectively but with no clear or comparable rationale. Against these values, our lower estimate (13,759 pairs – 95% confidence range: 7,153–25,861) appears high, despite being calculated by excluding April observations and larger coastal groups. The estimate for Britain in 2009 was 230,000 pairs (Musgrove et al. 2013), with the Welsh contribution being around 5% of occupied squares (Newson pers. comm.) at around 11,500 pairs. Brenchley et al. (2013) found a marginal increase of 9% in the number of occupied 10-km squares in North Wales between 1991 and 2008-12, while the UK atlas (Balmer et al. 2013) calculated a 10% decline in occupied squares in Wales generally over that same period, suggesting there had been shifts in distribution but no widespread population increase. However, for this species in particular, without a standardised, structured and representative sampling framework, and critically, a defined and consistently applied rationale for identifying 'pairs' and a method for representing sub-optimal habitats properly, both absolute population estimates and relative comparisons between surveys will be especially difficult to make with confidence. This species may require a dedicated survey method for accurate assessments of population size to be made. For this, our current structure provides a defined and repeatable framework.

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Molecular analysis of the diet of Pied Flycatchers (*Ficedula hypoleuca*) in the context of climate change, productivity and carry-over effects: a pilot study

Cathryn Tyrrell
c.tyrrell18@hotmail.co.uk

Crynodeb

Mae cyflymdra newid hinsawdd dros y byd yn ystod y 40 mlynedd diwethaf yn creu trafferth i rywogaethau sy'n methu addasu i newidiadau cyflym yn eu cynefin. Oherwydd bod niferoedd anifeiliaid di-asgwrn cefn yn cyrraedd ei uchafbwynt yn gynt, mae rhai rhywogaethau mudol yn cyrraedd eu mannau nythu ar adeg anghywir. Credir mai oherwydd hyn y mae poblogaethau'r Gwybedog Brith wedi lleihau o hyd at 90% yn y tair degawd ddiwethaf. Ychydig o ymchwil sydd wedi bod ar fwyd y Gwybedog Brith, gyda'r astudiaethau diwethaf bron 30 mlynedd yn ôl a bron pob dadansoddiad blaenorol yn dibynnu ar weld y prae. Yn yr astudiaeth yma, ychwanegir at wybodaeth o fwyd y Gwybedog Brith trwy ddadansoddiad molecwlar o samplau o lwybrau treuliad a gafwyd trwy ddyrannu unigolion oedd wedi marw o achosion naturiol. Dadansoddir data ar gynhyrchiant atgenhedlol a mas corff yn ystod arosiadau tra'n mudo er mwyn adnabod unrhyw effaith cario trosodd (COE) a allai gynnig eglurhad ychwanegol am y gostyngiad yn eu nifer. Cadarnhawyd presenoldeb dwy rywogaeth di-asgwrn cefn oedd wedi eu nodi'n flaenorol trwy ddadansoddiad gweledol; *Calliphora vomitoria* a rhywogaeth(au) *Ecdyonurus*. Awgryma'r canlyniadau fod y Gwybedog Brith yn hyblyg o ran bwydo, a bod bwyd y cywion yn dibynnu ar amlder rhywogaethau prae, beth bynnag yw oed y cywion. Awgryma dadansoddiad o setiau data nad yw'r rhywogaeth yma'n dioddef oherwydd COE o ran mas y corff yn ystod arosiadau tra'n mudo. Mae angen mwy o ymchwil i resymau posibl am y lleihad mewn nifer, ac ystyrir hyn. Bydd hefyd angen dulliau molecwlar ychwanegol i gael cofnod llawnach o fwyd y Gwybedog Brith.

Summary

The rapid rate of global climate change experienced over the last ~40 years is a concern to those species which are unable to adapt to fast changes in their environment. Earlier peaks in invertebrate abundance are causing problems for some migratory species in that their arrival at their breeding grounds is mistimed in relation to prey abundance. Believed to be as a result of this, populations of Pied Flycatcher have declined by up to 90% in the last three decades. Analysis of Pied Flycatcher diet is a poorly researched area, with the last studies conducted almost 30 years ago and almost all previous analysis involving only visual identification of prey species. In this study, knowledge of Pied Flycatcher diet is supplemented by molecular analysis of digestive tract samples obtained through dissection of naturally deceased specimens. Data on reproductive productivity and body masses during their migratory stopover are also analysed to identify potential carry-over effects (COEs) that might offer further explanation for their decline. Molecular dietary analysis confirmed two invertebrate species previously identified by visual analysis; *Calliphora vomitoria* and *Ecdyonurus* sp. Results suggest that Pied Flycatcher diet is very flexible and that nestling diet is dependent on abundance of prey species, regardless of nestling age. Analysis of datasets suggest that this migratory species does not suffer from COEs relating to their body masses in their migratory stopover point. Further investigations into potential causes of decline are necessary and are considered. Additional molecular methods are also required to produce a more substantial record of Pied Flycatcher diet.

Introduction

The Pied Flycatcher

The Pied Flycatcher, a small passerine species belonging to the family Muscicapidae (Figure 1), breeds in forest and woodland areas in the Palaearctic regions of the northern hemisphere, including northern Africa, western Siberia, south-west Asia and across Europe, and winters in West Africa (Hope Jones et al. 1977). Autumn migration begins during late July to early August and spring migrations begin in March, with the earliest arrivals in Britain occurring in mid-April, but peaking in late April and early May. In Britain, eggs are then laid from late April to mid-May (Campbell 1950). The species also has a major stopover point in Iberia where they accumulate fat reserves for the remaining migration to and from the breeding grounds. In the UK, the Pied Flycatcher inhabits mostly western areas of England, central areas of Scotland and almost all wooded upland areas of Wales (Balmer et al. 2013). Most knowledge of Pied Flycatchers comes from research conducted in their northern breeding habitats in NW Europe as relatively little is known of their migration periods and wintering grounds (Lundberg and Alatalo 1992).

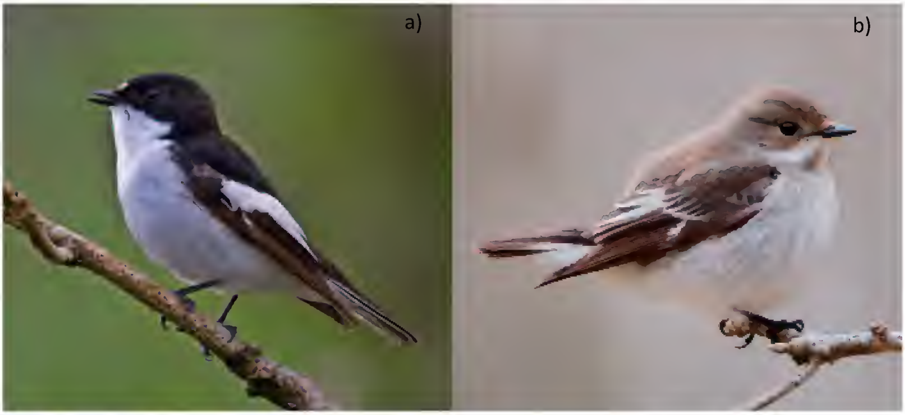

Figure 1: a) Male Pied Flycatcher in breeding plumage; b) female Pied Flycatcher. Photos: Bob Garrett.

The species nests in tree holes, but readily takes to nest boxes, and is more abundant in deciduous woodland than in coniferous forests, regardless of whether nest boxes are available, probably owing to food availability (Slagsvold 1975; Lundberg et al. 1981; Lundberg and Alatalo 1992). Pied Flycatchers used to be considered a very common species, with an estimated population of two million pairs recorded in Sweden in 1976, ranking it one of their most abundant migrant birds (Ulfstrand and Högstedt 1976; Lundberg and Alatalo 1992). However, with the recent changes in climate, invertebrate abundances in the northern breeding grounds are peaking earlier in the spring (e.g. Lepidopteran larvae), meaning Pied Flycatcher migrations are currently mistimed and causing many populations to miss these early spring peaks in food abundance during their breeding season (Both et al. 2006). As a result, populations of Pied Flycatchers are believed to have declined by around 90% in some areas of Europe since the 1980s and further declines are predicted in the future (Both et al. 2006). The diet of Pied Flycatchers is therefore crucial for understanding and estimating further declines.

Pied Flycatcher diet

Whilst it is assumed that adult Pied Flycatchers are almost entirely insectivorous, few studies have been conducted on their diet (Lundberg and Alatalo 1992). Studies have shown that ants are the most common prey, with sphecid wasps and beetles also accounting for a large part of the diet (Bibby and Green 1980; Silverin and Andersson 1984). More extensive research has been conducted on the diet of nestlings, probably due to the simplicity of collecting data for nestlings compared to mobile adults (Lundberg and Alatalo 1992). Research into nestling diet has suggested that nestlings are supplied with softer invertebrates than adults prey upon themselves, consisting mostly of Aranea, Lepidoptera and Diptera, while also including Hymenoptera and Coleoptera (Mansfeld 1942; Creutz 1953; von Haartman 1954; Meidell 1961; Bösenberg 1964; Dornbusch 1981; Silverin and Andersson 1984). In addition, the larvae of these invertebrate species are provided to nestlings in greater abundance than adult insects (von Haartman 1954). Adult Pied Flycatcher stomachs also contain far more ant species than nestling stomachs (Silverin and Andersson 1984). To my knowledge, there have been no further studies of the diet of these birds since the 1980s.

Molecular analysis of diet

Predator-prey interactions can be complex and it is often difficult to directly observe all of these interactions in the field (Symondson 2002). Analysis of the gut contents of predator species has long been used as a method of prey identification and diet composition of predators (Symondson 2002). Visual identification of prey species in the digestive tract has its limitations, including a biased view of prey choice, which includes human ability to accurately identify partially digested prey species considering that soft-bodied prey is more readily digested than tougher prey (Dennison and Hodkinson 1983; Feller et al. 1985; Symondson 2002). Molecular techniques are therefore deemed more reliable in the identification of prey remains (Symondson 2002). Furthermore, specimens are often euthanized in order to carry out the dissection, making this a very invasive technique. To avoid this, non-invasive faecal samples may be obtained from live birds or, alternatively, naturally deceased specimens or deceased specimens obtained from other studies may be used. Prey DNA may then be collected via dissection of the digestive tract and subsequent molecular analysis of its contents, which is the focus of this study. To date, PCR-based techniques (Polymerase Chain Reaction) for molecular dietary analyses have proven to be the most effective and versatile, yet they do themselves have some limitations (Symondson 2002). For example, molecular analysis does not inform us of prey choice by predators, nor do they provide us with quantitative analysis (Symondson 2012).

The current study

This study was based on naturally deceased adult and nestling Pied Flycatchers collected from woodlands in south Wales during a previous study, which I then dissected. Digestive samples were taken from two locations in the digestive tract; the gizzard and intestine. The aim was to examine the diet of Pied Flycatchers in one of their northern breeding areas, via molecular analyses of these digestive samples. Invertebrate DNA was then identified using general invertebrate primers, followed by sequencing to identify invertebrates to species level. The purpose of sampling from two areas of the digestive tract was to attempt to provide an overview of Pied Flycatcher diet over a longer length of time and to hopefully lessen the dietary analysis limitations of faecal samples which have potentially experienced further digestion and DNA degradation. In addition to dietary analysis, datasets on reproductive productivity in their breeding grounds and body masses during migration are analysed to investigate potential carry-over effects (COEs), which are defined as events occurring in one season that have significant residual impacts on avian populations in the following season (Harrison et al. 2011). They are caused by events which affect the energetic state of organisms or induce physiological stress on the organism, such as food shortages, disturbance (particularly anthropogenic) and habitat loss (Legagneux et al. 2012). These impacts have the potential to affect the productivity of individuals for up to 3 years after they were first impacted (Legagneux et al. 2012). Knowledge of which species are impacted by these effects is therefore essential in our understanding of and ability to conserve these species.

In this study I aim to re-evaluate the diet of the Pied Flycatcher, with the use of modern molecular techniques. I also aim to provide further insight into potential causes of decline in Pied Flycatcher populations, in the context of COEs. It is hypothesised that food composition of nestling diet changes depending on the development stage of nestlings, and that nestling diet is comprised of softer prey than an adult diet, as suggested by Meidell (1961). Finally it is hypothesised that declines in Pied Flycatchers are aided by COEs relating to their body mass during their stopover in their migration. Considering the very small sample size used for dietary analysis in this study, the aims outlined are mostly to provide a proof of concept for molecular analysis via dissection. That said, any information on Pied Flycatcher diet gained from this study would be a good contribution to a system where studies are lacking.

Materials and Methods

Dietary Analysis

Dietary sample information, dissection and DNA extraction

For this study I had access to deceased Pied Flycatchers collected during a PhD project (Goodship 2006). This study was carried out between late April and early June in 2003 and 2004 at two field sites located at Llysdinam, Newbridge-on-Wye, Mid Wales: Tŷ Mawr and the entrance to Ystrad House. Eight deceased specimens, 5 adults and 3 nestlings, were collected for future research and stored at -20ºC after collection. All specimens are believed to have died of natural causes, although the exact nature of their deaths is unknown. Unfortunately, little if any additional information was recorded at the time of collection (Table 1).

Subject	Sex	Ring Number	Additional Information
M1	Male	R221331	Adult.
M2	Male	M273776	Adult.
M3	Male	NA	Adult.
M4	Male	NA	Adult. Collected on 23/04/03. Found deceased in nestbox at Ty Mawr Lower.
F1	Female	R083012	Adult. Collected on 30/04/03.
N1	Not known	R21301	Nestling. 6cm from crest to rear. Estimated age of 10 days. Collected on 09/06/04.
N2	Not known	NA	Nestling. 5.3cm from crest to rear. Estimated age of 7-8 days.
N3	Not known	M273761	Nestling. 4.5cm from crest to rear. Estimated age of 5-6 days. Collected on 02/05/03.

Table 1. Information for the 8 specimens of pied flycatcher analysed during this study, obtained either before or during dissection.

The specimens were dissected and the digestive tract was separated out (Appendix, Figure 4). Digestive material samples were taken from the gizzard and from the entire length of the intestines. Full description of information collected during dissection may be found in the Appendix. Dissection equipment was sterilised using bleach, followed by dipping in 100% ethanol and flamed between each specimen and between each digestive organ in order to avoid contamination between specimens and between organs within each specimen. DNA was extracted using QIAamp DNA Stool Kit, Protocol: Isolation of DNA from Stool for Human DNA Analysis (Qiagen, Manchester, UK) following the manufacturer's instructions. The only exception to these instructions was that only half an Inhibit EX Tablet was added to each sample, as it is not a purely faecal sample. Once extracted from the specimen, the initial buffer (ASL) was immediately added to the digestive samples before proceeding directly to the remaining extraction process, or being stored at -4ºC until further use.

PCR amplification, purification, cloning and sequencing of DNA

Universal primers LCO1490 and HCO1777 (Brown et al. 2012) were used to amplify a 282 base pair region of the invertebrate mitochondrial gene cytochrome oxidase subunit I (COI) from the digestive samples, as used by King et al. (2015). These primers were analysed in silico using the sequence alignment software MEGA to predict prey species DNA amplification. The primers were shown to amplify the majority of invertebrate prey species, whilst avoiding amplification of any avian DNA in the sample. PCR reactions for the HCO/LCO universal primers were carried out in a total volume of 10µl consisting of 1 x Multiplex Mix, 0.1mg/ml BSA, 0.2µM of both forward and reverse primer and 3µl of DNA. PCR conditions required an initial denaturing stage at 95ºC for 15 minutes, 35 cycles of amplification at 94ºC for 30s, 46ºC for 90s, 72ºC for 90s and an extension stage at 72ºC for 10min. PCR products for samples with invertebrate DNA present with these primers were purified using QIAquick PCR Purification Kit (Qiagen). During this process, M1 stomach and M1 intestine remained separate, whilst N1, N2 and N3 stomach samples were pooled. The samples were then cloned using the QIAGEN PCR Cloning Kit following manufacturer's instructions. Colonies were stored in LB medium until the cloned inserts were amplified using M13 primers. PCR reactions were performed in total volumes of 15µl, using 1 x PCR Buffer, 1.5mM MgCl, 0.015mM dNTP mix, 1.5µg BSA, 0.1µM of both forward and reverse primer, 0.625 U Taq DNA Polymerase and 1µl of colony suspension. PCR conditions required an initial denaturing stage at 94ºC for 2min 30s, 35 cycles of amplification at 94ºC for 30s, 55ºC for 30s, 68ºC for 45s and an extension stage at 72ºC for 10min. PCR products were visualised in a 1.5% electrophoresis gel stained with 1µl SYBR® Safe. A sequence with a similarity of ≥98% was considered to be of this taxon, as described by King et al. (2015).

Data analysis: Productivity and body mass datasets

Data on the reproductive productivity of Pied Flycatchers from nest boxes located in the RSPB reserve of Cwm Clydach, Swansea, South Wales was compiled by the Gower Ornithological Society from 1986 to 2015. Data was also collected by A Rocha, in the Alvor estuary, Portugal documenting the body masses of Pied Flycatchers from 1987 to 2012 during their autumn migration on route to Africa. Productivity data for 1986 was discarded owing to just three samples in this year and due to no comparable body mass data. Productivity data after 2013 were also discarded as there was no body mass data after this year. No productivity data was collected during 2001 owing to an outbreak of Foot and Mouth which prevented any field observations in Cwm Clydach. Data was also not collected during 2002 and 2003 for unknown reasons. These datasets were then statistically analysed using a general/generalised linear model (GLM) with a gaussian family and identity link to assess any correlations between productivity in Welsh woodlands and body masses of juveniles, adults and all recorded individuals during their stop over in Portugal. The datasets were also analysed using the same methods to assess any correlations between body masses during their autumn migration in Portugal with their productivity in Cwm Clydach the following year.

Results

Cloning and sequencing of invertebrate DNA

Due to unknown circumstances, many colonies failed to amplify during the PCR. Of the colonies which were successful, none appeared to have taken up a sequence of invertebrate DNA. Instead it was attempted to sequence the PCR product from the purified samples of the original extracted DNA from the digestive tract samples. Meaningful sequences were obtained from this method, stating that Blue Bottle (*Calliphora vomitoria*) DNA was present in both the stomach and intestine of M1 and mayfly, *Ecdyonurus* sp., DNA was present in the pooled nestling stomachs (Table 2).

Productivity and body mass datasets

Initial analyses of correlations between productivity and body masses during migration stopover showed no significant correlations for adults, juveniles and all recorded Pied Flycatchers (not lagged) (Table 3; Figure 2). There were also no significant correlations found when comparing body masses in Portugal to productivity in Wales in the following year for adults, juveniles and all recorded Pied Flycatchers (lagged) (Table 3; Figure 3).

	Invertebrate sequence information						
Sample	Class	Order	Species	Common name	Query cover	Identity	GenBank accession number
M1 Stomach	Insecta	Diptera	*Calliphora vomitoria*	Blue bottle fly	98%	99%	KJ394710.1
M1 Intestine	Insecta	Diptera	*Calliphora vomitoria*	Blue bottle fly	99%	99%	KJ394710.1
Pooled N1, N2 and N3 stomachs	Insecta	Ephemeroptera	*Ecdyonurus* sp.	Mayfly	99%	98%	HG935046.1

Table 2. Invertebrate sequence information derived from the purified DNA sample obtained from dissection of the digestive tract of Pied Flycatchers.

	Adult		Juvenile		All	
	Not lagged	Lagged	Not lagged	Lagged	Not lagged	Lagged
Estimate	8.032	-1.101	-0.2009	1.424	-9.143	-9.415
SE	6.799	3.083	6.9199	6.234	7.831	7.330
t-value	1.181	-0.357	-0.029	0.228	-1.168	-1.284
Pr(>|t|)	0.303	0.7303	0.977	0.822	0.263	0.2130

Table 3. GLM results for correlations between productivity of Pied Flycatchers in Welsh woodlands and body masses at migratory stop over point in Portugal on route to Africa for adults, juveniles and for all recorded individuals. Results include comparison of productivity and body mass in the same year (not lagged), and productivity "lagged" to one year later than body mass.

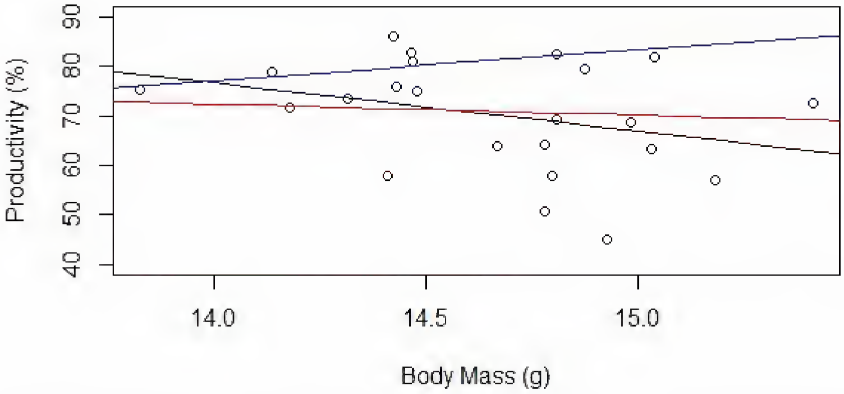

Figure 2. Average body mass of Pied Flycatchers recorded in Alvor, Portugal against average productivity recorded in Cwm Clydach in the same year (not lagged), from 1988 to 2013. Blue = adults, Red = juveniles, Black = all recorded individuals.

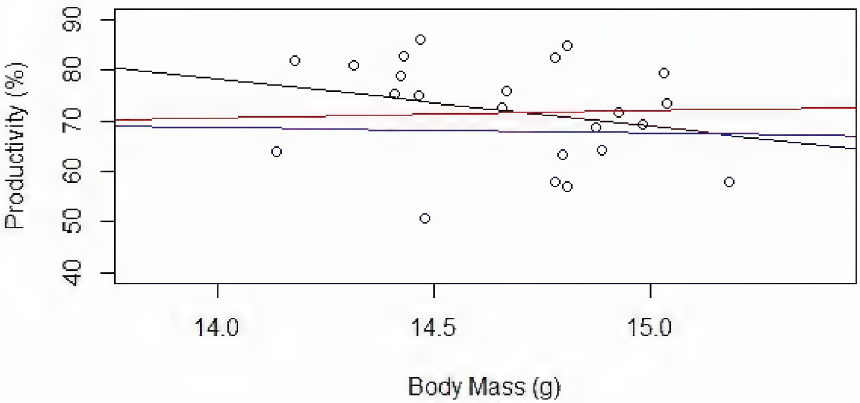

Figure 3. Average body mass of Pied Flycatchers recorded in Alvor, Portugal against average productivity recorded in Cwm Clydach in the following year (lagged), from 1988 to 2013. Blue = adults, Red = juveniles, Black = all recorded individuals.

Discussion

Molecular analysis of Pied Flycatcher diet

Whilst the results of this study proved to be rather limited with regard to Pied Flycatcher diet, it was found that adult Pied Flycatchers feed on *Calliphora vomitoria* (Order Diptera) and nestlings were fed *Ecdyonurus* sp. (Order Ephemeroptera), both of which have previously been recorded (Cramp et al. 1993). It has been suggested that food composition of nestling diet changes depending on the development stage of nestlings, with their diet comprising of progressively tougher, adult invertebrate prey (Betts 1954; Meidell 1961). Unfortunately, when using molecular techniques it is not possible to know if a prey species is in its softer larval form or tougher adult form. However, we can be fairly certain that the mayflies would be in their adult form, owing to their larval forms living underwater. In the current study the three nestlings varied in age, with the eldest nestling being ~10 days old (Table 1), but despite pooling the three nestling stomach DNA samples, one strong sequence was derived from the purified sample (Table 2). It may therefore be suggested that this species comprised the main bulk of the diet of all three nestlings, regardless of age. From these results we might agree with research by Slagsvold (1975) that suggests that, unlike resident birds such as tits (Paridae), which feed predominantly on Lepidoteran larvae, Pied Flycatcher diet is more flexible and is somewhat dependent on food availability at the time and place. From visual analysis conducted during dissection (Appendix) it appears that the Diptera sequence found in M1 stomach and intestine was from a larval stage, which indicates that adult Pied Flycatchers do still eat softer-bodied prey. However we cannot speculate about the diet composition of Pied Flycatchers in general from this analysis due to constraints on sample size.

It is not known why the cloning process failed for many samples in this study, as these molecular methods were followed from that used by King et al. (2015). It was initially thought that perhaps the competent cells had not remained in the LB medium for long enough to grow to sufficient levels for the following PCR, but this was tested by carrying out the PCR after differing amounts of time up to 5 days after the colonies were picked. In addition, of those that were successful, the PCR was carried out after 1-2 days of the colonies remaining in the LB medium. Furthermore, the exact same process was carried out in a parallel study analysing the diet of resident woodland passerines from faecal samples, in which the majority of samples were successful in the cloning process. One possibility to consider is contamination in the digestive samples. It is known that the samples contained invertebrate DNA which was able to be sequenced from the purified samples, however as the nature of the deaths of these specimens is unknown, it is possible that perhaps they may have ingested contaminants which potentially interfered with the PCR process with the M13 primers. However, PCRs with HCO/LCO primers had previously been successful. Alternatively, more modern methods of sequencing, namely next generation, may be more efficient.

Body mass and productivity

Considering the rapid recent decline of Pied Flycatchers, one might expect that the species may be suffering from COEs. However, analysis conducted in this study suggests that there are no significant correlations between the body masses of Pied Flycatchers during their autumn migratory stopover point one year and their reproductive productivity in the following year. This result might suggest that this particular species is not prone to COEs, or that changes in body mass on their migration is not an event which is causing the COE. Alternatively, population dynamics of Pied Flycatchers in Europe may be primarily affected by conditions during the breeding season itself (Newton 1998; Legagneux et al. 2012). This would support research conducted by Both et al. (2006) which suggested that the recent decline in Pied Flycatcher populations is due to the species becoming mistimed in their migrations as a result of global climate change, resulting in the population missing earlier peaks in invertebrate abundance in their breeding grounds. These unfavourable conditions experienced during the breeding season, with regard to food shortage, are likely to have large impacts on the number of nestlings which survive to fledge, and thus the productivity of the population.

There were also no significant correlations found between productivity in the breeding season of one year and the body masses of individuals at the migratory stopover point in the same year. This suggests that productivity is not correlated with body masses of individuals during their subsequent autumn migration, perhaps because adults and nestlings which survive to fledge must already be of a certain body mass in order to survive and begin their migration.

Further limitations of the study and recommendations for future research

Although all possible measures were taken to ensure all research was conducted reliably and ethically, there were limitations which should be noted. To begin with, there were several limitations regarding the Pied Flycatcher specimens. For example, there was no information about their collection and for many specimens the date of collection was also not recorded. Furthermore, we were unaware of how long the specimens were deceased prior to collection and the conditions they were exposed to, which may have aided their decomposition. These factors may have influenced the amount of DNA degradation, which may explain why many samples produced negative results for invertebrate DNA in the digestive tract. The cause of death was also unknown and whilst some observations were made during the dissection process (Appendix) which may provide insight into their deaths, no conclusions could be made. This may have provided bias to the study in terms of what these specimens were able to forage for and as deceased individuals are likely to not have eaten for some time prior to their deaths, or indeed may have died from starvation, this may have influenced the number of specimens with invertebrate DNA still present in their digestive tracts. For a more representative and non-invasive study of Pied Flycatcher diet, it may be recommended to collect faecal samples in future research. In addition, whilst this is a pilot study for molecular dietary analysis of Pied Flycatchers, the sample size was small and it is recommended that any future studies address this issue for more reliable results. A further recommendation for future dietary analysis is to identify any plant food items, as previous research has suggested that, although infrequent, the species does consume seeds and berries and that nestlings are sometimes offered berries in poor feeding conditions, which may be becoming increasingly important (Tompa 1967; Jordano 1987).

There were also limitations with the dataset analysis conducted during this study which could be improved. For the datasets, it should be noted that productivity data was only collected from one area in Wales, whereas the body mass data collected in Portugal presumably encompasses Pied Flycatchers which have come from all over the UK. This may have some bearing on the results of the analysis conducted. For example, birds in this area of Wales may have higher productivities than birds in other areas of the UK. In addition to this, the dataset gathered from Portugal was only collected during the autumn migration, not during the spring migration on route to their breeding grounds. It was therefore not possible to see if body masses at the stopover point in the spring migration have any immediate effects on breeding productivity. If this data could be collected it would provide a nice addition to analysis of carry-over effects and habitat quality during migration. One final thing to consider is the exploration of other factors, in the UK, in Iberia and in winter habitats in West Africa, which may be influencing Pied Flycatcher decline. As a migratory species, favourable conditions are required in all habitats in each season and along their migration. To date, little is known of Pied Flycatchers in their winter habitat and research during their migration is difficult (Lundberg and Alatalo 1992; Cramp et al. 1993). However, research in these areas may provide insight into their decline and what may be done in order to conserve and help the species. For example, during their stopover in Iberia, individuals accumulate fat reserves for the remaining migration, with average daily increases recorded in 1980 as 0.34g, and in 1986 as 0.225g and in many cases a 70% increase in weight is gained at these stopovers (Bibby and Green 1980; Veiga 1986). If food resources are becoming unfavourable in this habitat, then this may be having dramatic impacts on the survival rates of migrating birds to and from the breeding grounds.

Further investigations into reproductive productivity could provide additional insight into reasons for decline. For example, recent research has shown that there is substantial variation in the productivity of Pied Flycatchers in Cwm Clydach since the 1980s, with a slight decline overall (Jez Smith pers. comm.). Furthermore, the hatching success rate of broods is strongly correlated with the number of chicks which survive to fledge and there is also a slight decline overall in the hatching success of eggs over the last ~30 years. It is therefore suggested that the reproductive success of broods is largely determined by how many eggs survive to hatch (Jez Smith pers. comm.). Perhaps, then, the food shortage which Pied Flycatchers are experiencing due to the earlier peaks in invertebrate abundance is a problem mainly during the incubation period, rather than insufficient food supplied to nestlings. Whilst males help to feed nestlings, they never incubate eggs and only provide the incubating female with half of her food requirements (Curio 1959; Alatalo et al. 1988). The females must therefore leave the eggs to forage for the remaining food supplies, and with less food availability, females will need to spend more time foraging in search of sufficient food for their own survival and therefore less time incubating, which may be impacting how many eggs survive to hatch.

Another area of research is how we can improve productivity in their breeding grounds. For example, coniferous woodlands are almost entirely avoided as breeding grounds in the UK, which is believed to be because of less food availability than deciduous woodlands, but the species will inhabit coniferous woodlands if nest boxes are provided, which may suggest that it is also due to a lack of suitable nest sites in coniferous woodlands (Bösenberg 1964; Slagsvold 1975; Cramp et al. 1993). Introduction of nest boxes into these woodlands has therefore been shown to lead to extension of range in the Pied Flycatcher in Britain (Cramp et al. 1993). This might be worth considering for future conservation efforts as if their ranges may be extended then perhaps there will be less intraspecific competition for food and nest sites in deciduous woodlands, potentially enabling increased productivity and population numbers, but further research is required to explore this idea.

Finally, due to the time of year of the study, I was unable to conduct a reliable survey for invertebrate abundance in the breeding grounds which could have been used for comparison with the dietary findings. I therefore recommend that future studies also conduct invertebrate surveys which may identify the abundance of populations of ground-dwelling, tree-dwelling and airborne invertebrate species over the course of the breeding season.

Conclusion

Invertebrate DNA may be extracted from the digestive samples obtained by dissection, however sequencing of this DNA via cloning proved to be difficult. Future studies should perhaps investigate alternative methods of sequencing, such as next generation, and alternative methods of sample collection, such as faecal sampling. Molecular dietary analysis conducted in this study confirms prey species previously identified by visual methods, which offers a nice contribution to our knowledge of Pied Flycatcher diet. Analysis of productivity suggests that productivity of Pied Flycatchers is not affected by COEs relating to body masses during their migratory stopover. To identify other potential reasons for decline, more extensive research into Pied Flycatcher diet, migration, habitats and peak woodland invertebrate abundances is required.

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Appendix

Information and photographs derived from dissection of samples.

Specimen	Additional Dissection Information
M1	1 large larvae/maggot found in the stomach alongside other indistinguishable contents. 1 large larvae/maggot also found in the intestine. No crop found. No information about the collection of the specimen.
M2	Barely anything found in the stomach or intestines. Intestine appeared to be full of blood. No crop found. No information about the collection of the specimen.
M3	Intestine had large amount of faeces at the end of the large intestine near to the cloaca which was avoided in collection of the digestive sample. Very little, if anything, in either the stomach or intestine. No information about the collection of the specimen.
M4	Body had started to decompose . Intestines appeared paler than other specimens. Both stomach and intestines were full of digestive material. Some organs and body tissue had some black dots in them – perhaps disease/parasites. No ring number.
F1	Body quite decomposed – skin tore off when feathers were removed. Average amount of food in both the stomach and intestines. Body cavity had small amounts of clotted blood.
N1	Large liver and intestines. Fairly pale intestines at one end. A fair amount of digestive material in the intestines. Very tough stomach wall almost like cartilage. Also possessed a black and white ring.
N2	Quite fat. Very fragile skin, despite not appearing very decomposed. Feather also tore the skin when removed. Large, very delicate organs – intestine fell in half upon removal. Faecal sac present near cloaca, which was avoided in collection of the digestive sample. Lots of digestive material in the stomach, but little in the intestines.
N3	Small amount of digestive material in both the stomach and intestine. Bad looking liver. Another ring present in the bag reading “M273767”. Blue ring also present on leg.

Table 4. Specimen information noted during dissection.

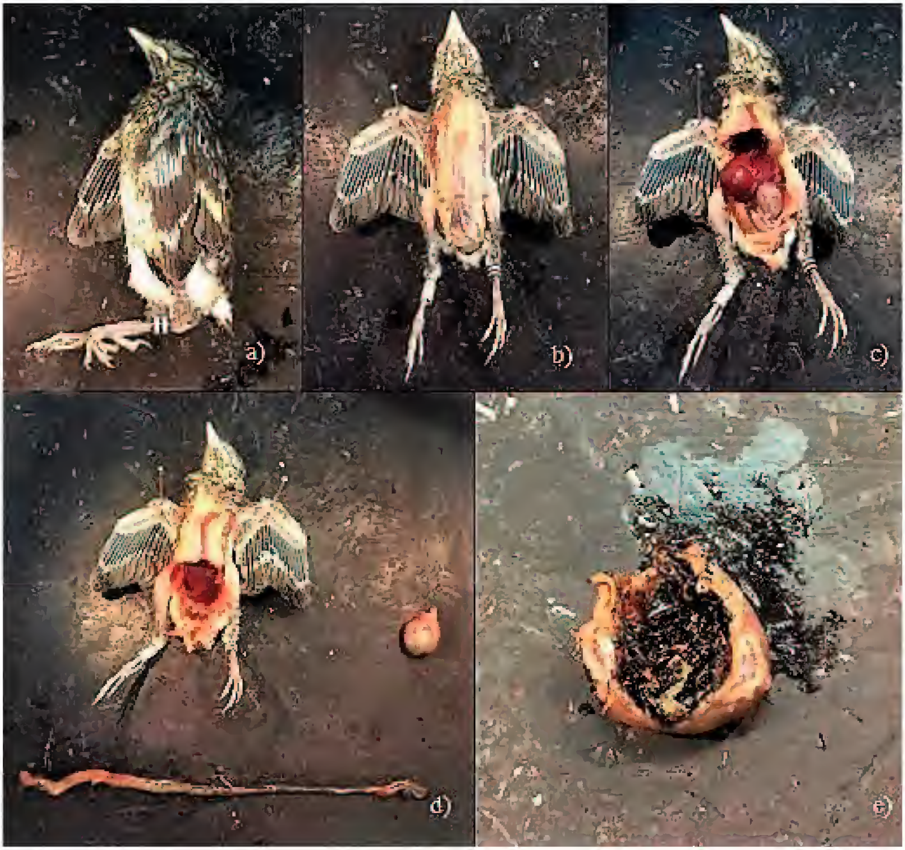

Figure 4. Photographs of the dissection process. a) original specimen, b) specimen with ventral feathers removed, c) specimen after having gained access to the internal chest and abdominal cavity, all organs intact, d) specimen with stomach and intestines removed, prior to extraction of digestive material, e) specimen stomach with incision to expose digestive contents.

Marsh Tits (*Poecile palustris*) and Willow Tits (*Poecile montanus*) in 10km square SN65 in Ceredigion

Ian Morris
1 Maesyfelin, Llangybi, Lampeter, Ceredigion SA48 8LY

Crynodeb

Wrth astudio'r adar sy'n nythu ac yn gaeafu yn sgwâr 10km SN65 gerllaw Tregaron yn neddwyrain Ceredigion, daeth yn amlwg fod poblogaethau cymharol iach o Ditw'r Wern a Thitw'r Helyg yn bresennol. Cafwyd hyd i Ditw'r Wern mewn 7 tetrad, gydag amcangyfrif o 7-12 o diriogaethau. Roedd Titw'r Helyg yn bresennol mewn 10 tetrad, gydag amcangyfrif o 10-13 tiriogaeth. Ymddengys fod y ddwy rywogaeth yn bresennol mewn rhannau gwahanol o SH65 oherwydd eu gwahanol anghenion o ran cynefin.

Summary

Whilst carrying out a study of the breeding and wintering birds in the 10km square SN65 near Tregaron in south-east Ceredigion, it became apparent that relatively healthy populations existed of both Marsh and Willow Tits. Marsh Tits were found in 7 tetrads, with an estimated 7-12 territories identified. Willow Tits were found in 10 tetrads, with an estimated 10-13 territories identified. Observations suggest that these two species appear to be spatially separated from each other in SN65 due to their differing habitat requirements.

Introduction

Since 2007 I have been studying the wintering and breeding bird populations near to where I live. I was prompted to do so by my involvement in the BTO National Atlas Project which ended in 2011. The results of the first phase of my study were published in the 2010 Ceredigion Bird Report. In November 2012 I began resurveying all the areas that I visited previously, a task which will take me five years. At the end of this time I aim to present an updated set of data for all the birds present.

I have become particularly interested in the Marsh and Willow Tits. Perhaps because they posed something of an identification challenge to me personally back in 2007, and sometimes still do, or maybe because of their relative scarcity and the knowledge that their numbers have been in decline across much of their UK range. A paper by Broughton (2009) discusses identification issues in some detail. I found the website xeno-canto to be helpful for learning calls and songs more thoroughly. Marsh and Willow Tits are always 'good' birds to see or hear and are a highlight of any birding outing. Though the second phase of the study is not yet complete, this short paper describes some of the findings since 2007 for these two species.

Methods

My study area is the 10km square SN65 which covers 100km^2 (Figure 1). It is bisected north-east to south-west by the River Teifi. West of the river much of the land is farmed intensively, though extensive areas of unimproved pasture do exist. The highest point is 257m. East of the river the ground rises more steeply, eventually reaching 484m at Bryn Brawd. The farmland seems generally less improved and at higher levels much of the land is wild and open or else covered by large tracts of coniferous plantation. Deciduous woodland forms as little as 1% of the surface area, with mature mixed deciduous and coniferous forest perhaps covering a similar area.

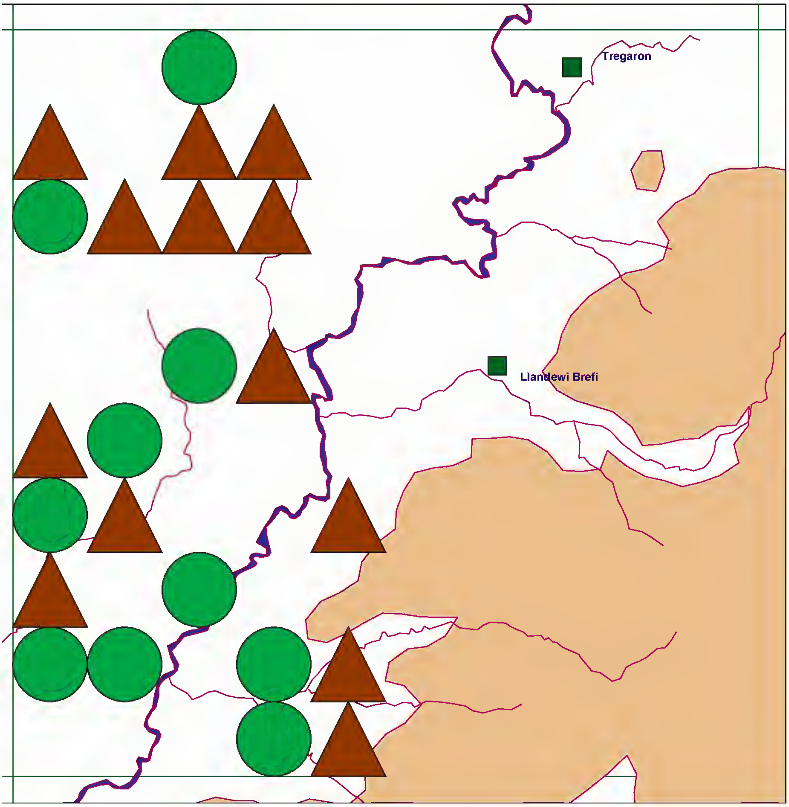

Figure 1. The 10km square SN65 and the distribu+tion of Marsh and Willow Tits within it by 1km square. The brown shading is land over 300m.

The basic survey unit was the tetrad, a 2x2km square, and SN65 is divided up into 25 such units. Each tetrad was visited twice in the winter and twice in the breeding season, each visit lasting two hours. Between autumn 2011 and spring 2012 I also sought to visit locations that were missed by the regular tetrad visits. These included a few small deciduous woodlands that were difficult to access due to their steep terrain and which I thought might harbour some overlooked Marsh Tits, amongst other species. Additionally, I checked several areas of fairly extensive birch/alder/willow carr, which had also not been visited previously due to time consuming access difficulties. I hoped to find Willow Tits in these areas.

Results

Marsh Tits

Perrins (2003), states that Marsh Tits prefer mature, unmanaged deciduous woodland with a thick shrub layer. Very little of this habitat exists in SN65. Hinsley et al. (2007) found that Marsh Tits need mature hedges and tree lines to move between woods. Habitat fragmentation was found to be a problem, especially for nestlings which seldom disperse more than 1km from their nest site. At lower levels at least, I would say that this aspect of their habitat needs is rather common locally. Breeding territories may be quite small but can be up to 8ha. (Perrins 2003). Winter territories are usually centred upon their core breeding area and a study found the average size to be 39ha (Broughton 2014).

I found Marsh Tits in 7 of my 25 tetrads. I have no definite evidence that any of these tetrads hold more than one pair but based on the amount of suitable woodland cover present in some tetrads it does seem quite likely, and suggests that enough of this habitat exists to support a population of between 7 and 12 pairs. There is a very close correlation between the location of most of these territories and the position of the fragments of deciduous woodland. Three territories appeared to

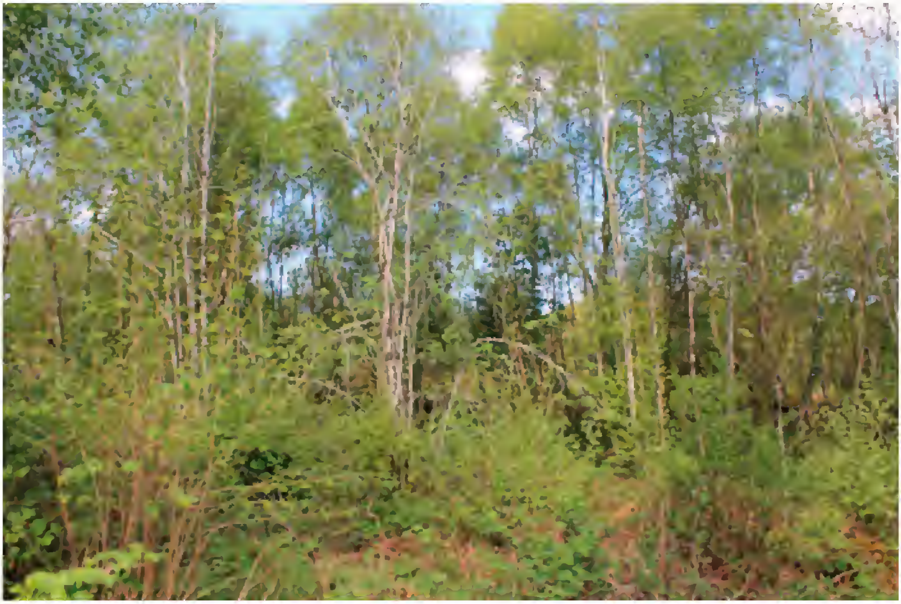

Figure 2. Long Wood community woodland - suitable for Marsh Tit. Photo: Mara Morris.

Locations of possible Marsh Tit territories	No. of territories
Long Wood (part)	1-2
Lletycybi plantation	1
Allt Clwt patrwm	1
Cockshead Wood	1
Allt Cefn y Garn	0-1
Allt Glan March	1-3
Clywedog catchment (above Llanfair Clydogau)	1-2
Allt Olmarch	1
Total	**7-12**

Table 1. Locations of Marsh Tit territories and estimated abundance.

be focused on the more extensive stands of deciduous/coniferous forest at Long Wood, Allt Olmarch (see Figure 2) and Cockshead. Outside the breeding season individuals may wander more widely in search of food and were seen on garden bird feeders at two locations. I think that I have visited just about all the optimum habitat in SN65 and it seems likely that a lack of suitable woodland could be a limiting factor on the population.

Willow Tits

Willow Tits are characteristically found in birch, alder and willow carr in boggy ground along river banks and in abandoned fields (see Figure 3), though they sometimes occupy drier sites too (Lewis et al. 2009). Both their breeding and wintering territories are generally quoted as being a little larger than those of the Marsh Tit (Perrins 2003).

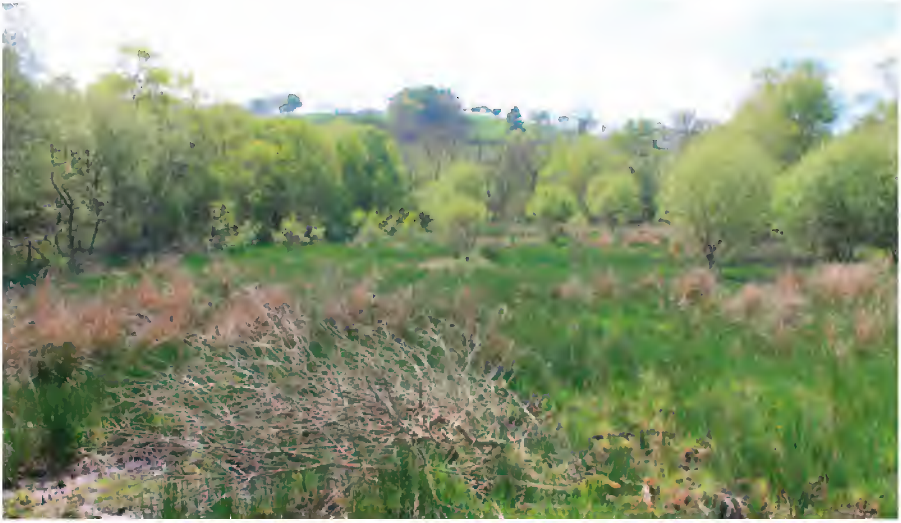

Figure 3. Waun Garthenor, habitat suitable for Willow Tit. Photo: Mara Morris.

Locations of possible Willow Tit territories	No. of territories
Pont Llanio	1
Waun Garthenor	1
Comins Capel Betws /Stags Head /Llanio	3-4
Afon Dulas (Llangybi-Olmarch)	1-2
Teifi Valley (below Pont Gogoyan)	1
Capel Betws Lleucu (Aeron valley)	1
Clywedog catchment (above Llanfair Clydogau)	1-2
Allt Olmarch	1
Total	**10-13**

Table 2. Locations of Willow Tit territories and estimated abundance.

I found Willow Tits in 10 of my 25 tetrads. Some of these tetrads appear to have enough suitable habitat to support more than a single pair and so I think the population lies in the range 10-13 pairs. On the 1:25000 scale ordnance survey map the habitat they occupy tends to be marked as "bracken, heath or rough grassland," and this covers approximately 5% of SN65. But whilst much is indeed rather open in appearance, in some places it has been invaded by trees through a process of succession, and it is these areas that Willow Tits seem to favour. It is hard to be sure if all of the suitable habitat was explored and my population estimate could still possibly be a little low. One of the territories seemed to be centred in coniferous woodland at Allt Olmarch, in contrast to their usual habitat, described above. Birds were noted on garden feeders at two locations during the winter.

Discussion

Interactions

Marsh and Willow Tits were recorded in 13 out of the total of 25 tetrads. Both species were present together in five of these (BCDHJ), though not necessarily in the same 1km squares. In Llangybi, Willow Tits occur in typical habitat along Afon Dulas, the old railway line and around an old millpond, whilst Marsh Tits were only found on a ridge above the village in a deciduous plantation. Mullarney et al. (1999), state that Willow Tits never attend bird tables. However, I once watched one of these Willow Tits for ten minutes regularly taking food away from a table, perhaps to stash it. Not far away at Denmark Farm Conservation Centre (outside the study area), Willow Tits are very regular on the feeder. Marsh Tits do not presently occur at Denmark Farm at all.

In Allt Olmarch one could say that both species occur in slightly atypical habitat, with Marsh Tits within mature mixed forestry on the lower slope and Willow Tits in immature coniferous forest above them. I have never noted either of them in the other's patch. Nearby, in circumstances similar to those in Llangybi, Willow Tits were found at Waun Gathenor, an area of wet woodland near the Teifi and Marsh Tits just over the road in mature deciduous woodland at the top of Cockshead Wood. This type of clear separation due to differing habitat preferences was also obvious in two other tetrads.

In contrast to these observations is the situation above Llanfair Clydogau, where a thin ribbon of deciduous woodland follows the line of Nant Clywedog. About a kilometre from the village it divides into three streams which fan out into an area of small fields, some of which are overgrown and scrubby, and which are surrounded by mature trees. A little way above this is a wetter zone invaded by willow and birch before finally opening out to open ground higher up. One or two Marsh Tit territories may be located in the lower woodland and one or two Willow Tit territories in the wet carr. These habitats tend to blend imperceptibly together in a gradual transition and there is a narrow zone in which I have recorded both species, though never on the same visit.

This study has found that Marsh and Willow Tits appear to be very often spatially separated from each other in SN65. Their habitat requirements must be very distinct from each other, more than I would have realised a few years ago and this may be enough to keep them apart for much or even all of the time and so reduce competition. I have never seen both species together at the same time and place and it has been my experience that it is very unusual to find either species away from its preferred habitat. Indeed, both species have a reputation for sedentary behaviour and territorial loyalty (Perrins, 2003).

Trends

I have presented the results by amalgamating the data from winter and spring as well as the supplementary visits into a single estimate which I think gives a more accurate idea of the numbers present. I have done this because both species are very loyal to their core territories throughout the year and also because their rather scarce and elusive behaviour means that I could easily have overlooked them at one or other season. Reasonable populations appear to exist in SN65 for both species but without previous data it is not currently possible to say whether these populations are stable or not.

Since their UK populations have declined by more than 50% since the 1970's, and continue to do so, these are red listed species of major conservation concern. This decline is thought to be occurring in Wales too, though since there is less available data here the extent of the decline is less clear. The causes of this situation are a matter of concern that is stimulating further research and debate. I hope that my conclusions regarding the populations of Marsh and Willow Tits in SN65 are correct and that locally here at least they may be continuing to thrive, albeit in relatively small numbers.

Acknowledgements

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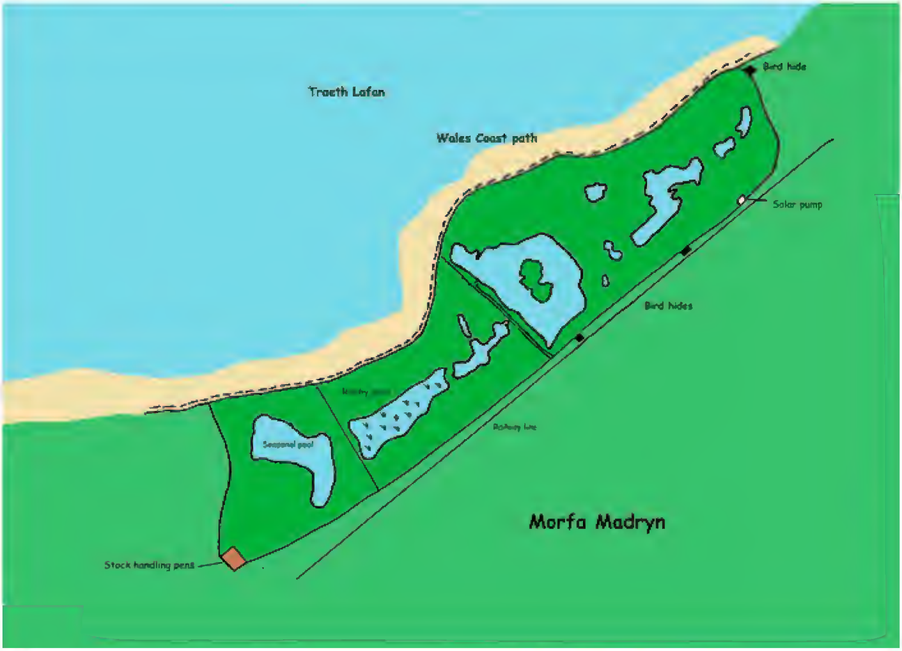

Map of Morfa Madryn Local Nature Reserve, near Llanfairfechan. Map drawn by Hilary Kehoe.

Morfa Madryn Reserve, its management and birdlife

Ian Hawkins
RSPB Cors Ddyga, Tai'r Gors, Gaerwen LL60 6LB

Crynodeb

Crëwyd Gwarchodfa Natur Leol Morfa Madryn yn 1994, yn dilyn y gwaith o droi'r darn cyfagos o'r A55 yn ffordd ddeuol. Prif amcan rheolaeth, yn cynnwys cynllun pori, yw cynnal neu gynyddu'r nifer o barau o'r Gornchwiglen (*Vanellus vanellus*) sy'n nythu ar y warchodfa. Dros yr ugain mlynedd diwethaf, Morfa Madryn sydd wedi dal y nifer uchaf o barau yng ngogledd Cymru.

Summary

Morfa Madryn Local Nature Reserve was created in 1994 following work to convert the adjacent section of the A55 into a dual carriageway. Management, including appropriate grazing, is primarily aimed at maintaining or increasing the number of pairs of breeding Lapwing (*Vanellus vanellus*) on the reserve. Over the last twenty years, Morfa Madryn has held the largest Lapwing colony in north Wales.

Introduction

Morfa Madryn is a small, well-loved, Local Nature Reserve on the North Wales coast, reached by a pleasant fifteen minute walk towards the west along the coastal footpath from Llanfairfechan. It

View of the main pool at Morfa Madryn LNR. Photo: Rhion Pritchard.

lies on the southern edge of the Traeth Lafan Sands Special Protection Area (SPA), and has a mixture of coastal grassland, reed beds and brackish pools protected by a shingle ridge.

Four species of waders have bred there in recent years, and a further two species have bred in the past, which is remarkable for such a small reserve. It also provides a roost site for some of the thousands of birds driven off Traeth Lafan Sands at high tide. Perhaps most importantly, it hosts the backbone of the north Wales Lapwing population along with the RSPB's Morfa Dinlle and Cors Ddyga (formerly Malltraeth Marsh) reserves. It has also turned up its fair share of rare migrants over the years.

The reserve is jointly owned by Gwynedd Council and Conwy County Borough Council, and is farmed by the Kehoe family who live nearby. The RSPB has provided management advice and continue to monitor the breeding waders. It's a wonderful example of collaboration - often opportunistic and hand-to-mouth, particularly in these austere times - but which thrives through the efforts of individuals across many organisations and walks of life.

History and development of the site

The land was originally marshy grassland, being described in a 1987/88 student project as "permanent, semi-improved pasture valuable to wading birds and ducks as high tide roosting and feeding areas". During the conversion of the adjacent section of the A55 into a dual carriageway, part of the land was used as a base for the work force and as a tip for the inert waste from construction. The original plan was that the dumped waste material from the Pen y Clip tunnel would be capped with top soil and restored to agricultural land.

As the prefabricated cabins were moving off, the eastern fields were covered with hundreds of heaps of tipped spoil, with topsoil stored elsewhere in huge bunds, all ready for restoration to agricultural land according to the planning permission. The original permanent pasture fields at the eastern end were long gone and would never return. The idea of restoring the land as a bird reserve and not agricultural land came from Peter Schofield, at that time chair of the North Wales Wildlife Trust. Gwynedd County Council (the principal managers of the adjoining Traeth Lafan Local Nature Reserve) took up the idea, but its implementation was not straightforward. There was a planning condition defining the end-restoration imposed by Arfon Borough Council, the privately-owned land was still under the control of the contractor, and the costs of purchase and creation of a suitable topography for the reserve had to be found. However, by working together with all the stakeholders, Gwynedd C.C. were able to purchase the land and Arfon B.C. agreed to the changed end-use. The road contractors carried out the physical work in summer 1994, but what could be achieved was constrained by the money available. Jill Jackson and Barbara Owsianka from Gwynedd C.C. and Dave Elliott (manager of RSPB Conwy) spent long hours poring over maps and calculations of volumes of spoil to come up with a viable design. Much of the carefully stored topsoil was either buried, or kept at one end of the reserve, to ensure that vegetation growth would not be too lush near the pools and scrapes. The contractors followed the design to create the landform visible today.

Management of the LNR

In the earliest years, getting the reserve grazed was a constant battle. A local farm would pay for a grazing licence, and then not utilise it, so the vegetation grew too long for the breeding waders.

The councils had no powers to get the land grazed. In 1998/9 the Kehoes heard about these difficulties, and agreed to graze to achieve a certain condition – this was novel for its time, at least for the council staff involved - and the situation improved rapidly. The following year they were awarded a business tenancy so they could enter Tir Gofal, and their excellent management has continued ever since. Additional funding was provided on an annual basis by the Countryside Council for Wales to help with the management of the site as a Local Nature Reserve.

Although visitors to the hides only see those Lapwings breeding on the grassland surrounding the lagoons and scrapes, the two fields to the south-west are also important for breeding birds. These fields have been very carefully managed over the years with the creation of more marshy areas and scrapes and the creation of patches of disturbed ground - all to encourage breeding waders. They have also always been carefully grazed by livestock at a level agreed with reserve managers (especially during the breeding season).

In 2001, the reserve was put into the first round of the Tir Gofal scheme, which helped to fund small-scale scraping to create "brown areas" (disturbed bare ground favoured as nest sites by Lapwings), and install sluices and a solar pump to extend the areas of water and wet marsh. For the first few years it was grazed with sheep, and many hours were spent hand-pulling the ragwort that proliferated on the disturbed ground. Cattle supplemented the sheep, once the ragwort had been removed, and helped to bring the ranker grasses under control.

The management was aimed at encouraging breeding Lapwings which need a short sward, and so it has been grazed hard from the start. Livestock are kept out only while the Lapwings are incubating, then slowly introduced from early June, when grazing and disturbance of the ground helps the Lapwing families to feed. Ewes with single lambs, or cattle that have been wintered outside, are chosen because they are calmer and thought less likely to trample any Lapwing chicks. Care is taken to round livestock up at walking pace, again to reduce the risk of trampling late broods of young.

The continuity of grazing by the same flock has resulted in the sheep becoming hefted. They have learned the best routes around the wettest areas and even how to swim out to the islands in the brackish lagoon. This knowledge is passed on from ewe to lamb. The flock now also graze the foreshore in the winter, from Glan y Môr Elias in the east almost to Aberogwen in the west, and again the hefting is vital when grazing safely to the rhythm of the tides. Hardy Highland and Belted Galloway cattle are also used on the reserve. As well as keeping the coarser grasses in check, they help to keep the pool margins open, and can be kept outside all winter. Any supplementary winter feeding is rotated around the fields to create patches of lightly poached ground as feeding areas for Lapwings the following spring.

Recent Developments

In 2008, the second round of Tir Gofal funded a further two sluices and an improved solar pump. It also paid for two internal fences, the restoration of a traditional slate fence, and in 2012, a chestnut–paling fence which is in place from spring to autumn. This ensures that the nesting Lapwings cannot see dogs accompanying walkers on the coastal footpath. Since the end of the Tir Gofal scheme in 2011, there has been no new funding. Single Farm Payments allow the Kehoes to continue grazing, maintaining the fences, and scraping out new "brown areas" as and when they can. In recent years, predation by foxes and crows has become an increasing problem and so action is taken to control these species prior to the breeding season.

Experience managing the Madryn reserve has helped the Kehoe family to take on new challenges. Hilary - inspired by the links between farming and conservation learned at Madryn - became the Anglesey Grazing Animals Project (AGAP) Officer, and subsequently the North Wales Regional Development Officer for PONT (Pori, Natur a Threftadaeth – Grazing, Nature and Heritage). Andy has diversified as a conservation contractor, and now works across north Wales. Over the years, their continuity has proved vital: a catalyst to look for funding opportunities to improve things during the good times, and for digging deep and keeping the bare maintenance going in the more recent austere times.

Breeding Lapwings

Morfa Madryn has supported the largest Lapwing colony in north Wales for the last two decades. Monitoring has been carried out in most years since 2003. The data show an increase in the early years to a peak of 44 pairs in 2006, then a gradual decline to 18 pairs in 2014. This caused concern and so control of Carrion Crows and foxes prior to the breeding season was increased. Since then numbers are showing signs of recovery, with 37 pairs in 2016 and 30 in 2017.

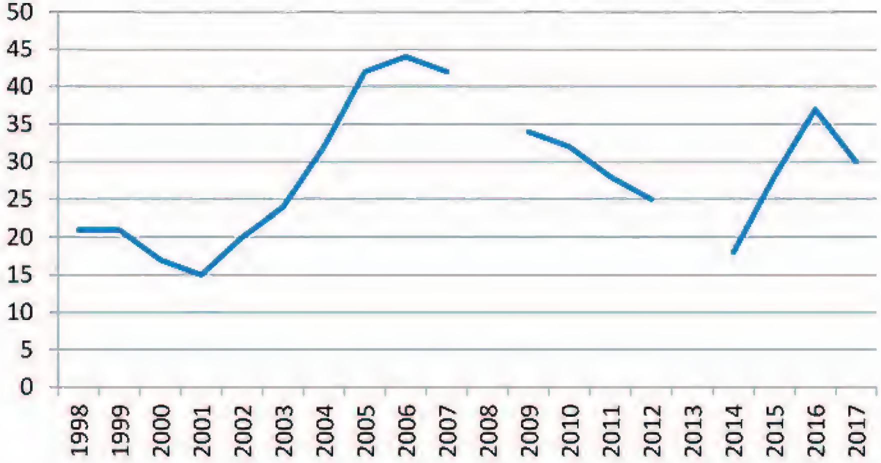

Figure 1. Number of pairs of Lapwing breeding at Morfa Madryn LNR 1998-2017.

With scant resources for monitoring at Morfa Madryn, nest success and productivity have not been studied until recently. In 2008, temperature loggers were placed in nine nests as a means of assessing levels of predation and hatching success and to gain an indication of the causes of nest failure. Of the nine nests, two hatched full clutches, two suffered partial predation, and the remaining five were predated. Predated and partially predated nests were lost to both nocturnal and diurnal predators, with nocturnal mammals (probably Foxes) and Carrion Crows (*Corvus corone*) being the likely predators.

Population modelling for Lapwings suggests that a stable population requires an average of 0.7 young fledged for every breeding pair; this figure is slightly lower than the 0.83 quoted in the standard monograph on the Lapwing (Shrubb 2007). Recent figures for the number of young fledged at Morfa Madryn are only available for 2014-6, the productivity being 0.6 in 2014, 1.8 in 2015, and 0.7 in 2016. In general, the management and predator control seem to be working and the colony appears to be recovering both in terms of numbers breeding and the number of young fledging.

Other breeding birds

In addition to the Lapwings, around three pairs of Oystercatchers (*Haematopus ostralegus*) also breed, and Ringed Plover (*Charadrius hiaticula*) breeding numbers have shown an increase since the winter-grazing and spring-resting of the foreshore started a few years ago. Redshank (*Tringa totanus*) bred regularly here until 2002, followed by a record of two juveniles in 2006. Breeding by a single pair resumed in 2015 and continued for the following two years in the wet field to the west of the main lagoon (W Myerscough pers comm). This is now the only breeding site in Caernarfonshire (Pritchard 2017).

Morfa Madryn has also been a surprising breeding site for Dunlin (*Calidris alpina).* A pair was said to have been seen with one chick at Morfa Madryn in 1996 (Barnes 1997). Pairs were present at this site every year over the next ten years, and one bird was evidently incubating eggs in 1998, though no chicks were seen. Birds performed song-flights over the main brackish lagoon and nesting presumably occurred in this area. In 2003 three pairs were showing signs of breeding activity on 10th June, with one bird apparently sitting on eggs. Three pairs were noted here again in 2007, but there has been little indication of possible breeding at this site since then, though a pair was reported present in May 2012 (Pritchard 2017). The habitat here is fairly similar to the machair of the Outer Hebrides where Dunlin breed commonly. Little Ringed Plover (*Charadrius dubius*) were present in 1996 and probably bred (Pritchard 2017).

A survey in 2003 under the RSPB Volunteer and Farmer Alliance scheme found 47 species of breeding bird, including scarcer breeding species such as Grasshopper Warbler (*Locustella naevia*) and Water Rail (*Rallus aquaticus*). In 2015, a pair of Black-headed Gulls (*Chroicocephalus ridibundus*) nested, increasing to four in 2016 and at least five pairs in 2017 (W Myerscough pers comm). Numbers may be higher, but it is hard to count exact numbers as they tend to get hidden by the growing grass.

Bird life at other seasons

The main lagoon and island are used as a high tide roost throughout the year. Numbers are highest in winter with up to 500 Redshank, 2,000 Dunlin, and 200 Curlew (*Numenius arquata*). If the vegetation is short enough, the Curlew can spill over onto the grassland in front of the hides giving wonderful views. Few of the Oystercatchers feeding on Traeth Lafan roost at Madryn, but a large roost is usually located on the Glan y Môr Elias shingle spit and is visible from the shore hide at Morfa Madryn. All these birds are counted once a month from August to March at high tide by a member of the Traeth Lafan WeBS Count team. Careful scrutiny of the waders can reveal scarcer passage waders such as Ruff (*Calidris pugnax*) and Curlew Sandpiper (*Calidris ferruginea*), and the roost can be very good for Greenshanks (*Tringa nebularia*). The reserve has also thrilled visiting and local birders with more than its share of scarcer birds; with Grey Phalarope (*Phalaropus fulicarius*), Pectoral Sandpiper (*Calidris melanotos*) and most recently a Citrine Wagtail (*Motacilla citreola*) in the last few years. It is even worth looking in the surrounding hedges and trees - Firecrests (*Regulus ignicapilla*) and Yellow-browed Warblers (*Phylloscopus inornatus*) were both recorded in autumn 2016.

Public access and facilities

Facilities for visiting birdwatchers include a hide at the extreme NE tip of the LNR (which gives good views across to the wader roost on the Glan y Môr Elias shingle ridge), and two hides on the inland side of the reserve. These are reached along a dead-end path beside the railway track. The furthest hide gives good views of breeding waders, and of water birds roosting on the island in the lagoon. There is no public access to the two fields beyond the furthest hide, but they are readily viewed from the Wales Coast Path which runs along the seaward side of the entire LNR.

Access is best from the beach car park at Llanfairfechan about a mile to the east. It makes for a very pleasant walk along the Wales Coastal footpath. Alternatively visitors could park at the Aberogwen Car Park about 2 miles to the west and enjoy an equally pleasant walk along the southern edge of Traeth Lafan.

The future

It is vulnerable to the vagaries of the economy. With mounting pressures on councils a nature reserve can seem a luxury, and Madryn relies on volunteers and the dedication of the two councils' countryside services team for the upkeep of its hides and trail. The Kehoes' devotion to the site and its wildlife has helped the reserve flourish over the past two decades; their daughter, Celyn, has grown up working on Madryn, and is as every bit hefted to the reserve as the sheep, so hopefully a wildlife-friendly way to farm will be found whatever Brexit brings.

Madryn is also vulnerable to climate change. The sea occasionally breaks over the shingle ridge. Up until now, it has only taken a small amount of work to reinstate the ridge but the shoreline management plan (Guthrie 2011) has it as a 'do nothing' section, so this may not continue in the future, although the main railway line along the southern edge needs protection.

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Owsianka and Hilary Kehoe for their input into the paper, and Geoff Gibbs, who acted as referee, for his valuable suggestions.

Volunteering

I hope this article demonstrates how Local Nature Reserves, indeed most nature reserves, rely on the goodwill and dedication of individuals, both within the local community and public and charitable organisations.

I write this article during National Volunteer Week, so if you enjoy Morfa Madryn or any nature reserve near you, please consider volunteering some time to help it. Most organisations – and private landowners – both welcome, and need, any help they can get. The work is often very rewarding, leading to an improved understanding, appreciation, even love of the jewels that we all have on our doorsteps.

Promotion of Bird Surveys and Monitoring in Wales: current and required

R. I. Thorpe and Anne Brenchley
Bryn Llus, Rhostryfan, Caernarfon, Gwynedd LL54 7PF

Crynodeb

Mae'r papur yma'n edrych ar gynlluniau presennol i fonitro a chofnodi adar, ac yn awgrymu rhywogaethau y dylid eu targedu gan gynlluniau monitro newydd.. Nodir cyfanswm o 25 rhywogaeth fel blaenoriaethau, gyda'r Gnocell Fraith Leiaf (*Dendrocopos minor*) a'r Cudyll Bach (*Falco columbarius*) yn cael y flaenoriaeth uchaf. Ceir manylion am ddulliau cynnal arolwg o'r rhywogaethau hyn ar safle we CAC.

Summary

This paper looks at existing bird monitoring and recording schemes and suggests species which should be targeted by additional monitoring schemes. A total of 25 species are identified as priorities, with Lesser Spotted Woodpecker (*Dendrocopos minor*) and Merlin (*Falco columbarius*) given the highest priority. Details of suggested survey methods for priority species are available on the WOS website.

Introduction

The purpose of this paper is to provide an overview of, and context to, the monitoring of bird populations in Wales, and to identify:

- Existing “significant” monitoring schemes which WOS should proactively support - through encouraging members/observers to participate.
- The need for additional monitoring effort/schemes to provide data to guide, focus and evaluate bird conservation effort in Wales.

We hope that this important first step in collating the meta-data for monitoring efforts will highlight the current range and scope of surveys in Wales and acknowledge their value in providing data on which to formulate bird conservation strategies, recognising that Welsh priorities may not be the same as UK priorities. It is not intended to be a critique of the surveys in Wales, but does aim to identify short-term priority gaps in species data and develop ideas on how to fill those gaps, principally guided by the WOS, supported by BTO Cymru and RSPB Cymru and undertaken by county/local bird club members and other regular volunteer surveyors.

It is intended that this paper is used in conjunction with information on the WOS website. The website contains details on suggested survey methods etc. and how you can be involved (**https://birdsin.wales**).

The paper is split into five sections:

1. Current monitoring of bird population trends in Wales, encompassing annual, periodic and one-off surveys.
2. Reporting survey information.
3. Recommendations for future surveys and monitoring - Priorities for survey work in Wales.
4. Monitoring approach.
5. Getting involved.

Improving the first (e.g. more participants/coverage) and developing the second will, in combination, facilitate a better and more up-to-date assessment of the status of bird populations in Wales to assess:

- the impact of conservation or other strategies;
- population trends in Wales in the context of changes in other parts of UK;
- the importance of a site/population in Welsh/UK/International terms) ;
- how populations are responding to environmental change.

1. Current Monitoring of bird population trends in Wales

Welsh-level surveys, or the Welsh component of UK-level surveys, are typically designed to provide information on population level/range of species or establish trends over time – either through actual counts or by use of an index. For some species with limited numbers/range, specific surveys covering all known and potential sites are possible, but in most cases a sampling approach is necessary and here, usually, the larger the number of sites/areas/squares surveyed the more useful the results. The limits of sampling are usually determined by the availability of fieldworkers to undertake coverage. These surveys provide the fundamental data base for producing Birds of Conservation Concern for Wales.

All surveys are primarily undertaken by volunteers, many of whom are highly skilled.

- Breeding Bird Survey (BBS) – this annual monitoring scheme, coordinated by the BTO, started in 1994 (replacing the Common Birds Census) and records population changes for most of the UK's commoner species. In the UK, BBS and CBC data can be combined to produce trends since 1962 for many species but this is not possible for Wales due to historically sparse CBC coverage in the country. In 2016, 333 squares were surveyed in Wales, making it feasible to report trends for 56 species. This survey is at the core of monitoring populations of terrestrial birds in Wales and many more randomly selected squares are available for survey. An annual report is published, the latest of which is for 2015 (Harris et al. 2016). The 2016 report will be available by the end of 2017. The BBS is jointly funded by the BTO, the Joint Nature Conservation Committee (JNCC) and the RSPB.

- Atlases –these cover all breeding and wintering species at the recording unit of 10km^2. Four UK Atlases have been completed. The first breeding atlas was undertaken in 1968-72 (Sharrock 1976). This was followed by a wintering atlas in 1980-84 (Lack 1986), a second breeding atlas from 1988-91 (Gibbons et al. 1993) and most recently a combined breeding and wintering atlas (Balmer et al. 2013). They were organised by BTO, Scottish

Ornithologists' Club and BirdWatch Ireland.

- Local Atlas(es) – many local atlases have been completed in Wales since 1968. These have usually been done at the region or county level and the recording unit is a tetrad (2x2 km). The most recent published local atlases (since 2010) cover East Glamorgan (2014) and North Wales (Brenchley et al. 2013).

Species /Habitat specific

- Wetland Bird Survey (WeBS) – The UK is of outstanding international importance for waterbirds. Lying on some of the major flyways for Arctic nesting species, huge numbers of waterfowl are attracted, especially during winter, by the relatively mild climate and extensive areas of wetland, notably estuaries. Implemented in 1975, WeBS is a scheme to monitor populations and trends in the numbers of non-breeding waterbirds; their distribution and to identify important sites. Monthly counts are undertaken on or close to set dates. The overall coverage of coastal sites is good but WeBS is not just a coastal survey and many inland lakes, ponds and rivers are also surveyed to monitor populations of more dispersed species. WeBS strives for representative coverage and there are still many rivers and small lakes that could be included in the sample for counting. Annual reports are published the latest of which is for 2015-16 (Frost et al. 2017) WeBS is funded by BTO, JNCC, RSPB in association with WWT.

  NEWS (Non-Estuarine Wetland Survey) – a periodic augmentation of WeBS this UK survey is usually repeated every nine years (with aspiration for every six years in the future) and was last undertaken in 2015-16. Welsh coverage was extremely good.

- Waterways Breeding Bird Survey (WBBS) – Running since 1998 and replacing the multiple-visit Waterways Bird Survey, the field protocol for WBBS is similar to BBS but volunteers walk along a length of canal or waterway from 500m to 5km, twice in each breeding season. Now incorporated with BBS-Online, this survey provides valuable data, particularly for riverine species. Only 27 WBBS surveys were undertaken in Wales in 2017 but more random stretches are available for uptake.

- Seabird Monitoring Programme: An annual "sample survey" of key seabird colonies, these contributing to a UK Recording scheme coordinated by a partnership led by JNCC. There is considerable scope to increase the number of colonies counted each year, and to also count sites inland where gulls, terns and Cormorants may nest.

- National Seabird Surveys: A periodic survey of all coastal seabirds and inland breeding gulls and terns. A repeat survey is being carried out between 2015 and 2018 - this being the fourth census of all breeding seabirds in Britain and Ireland, following on from Operation Seafarer (1969-70), the Seabird Colony Register (SCR; 1985-88) and Seabird 2000 (1998-2002). A lack of funding within the JNCC to enable national coordination of a full census has been a significant barrier, however efforts are underway to try and ensure that Wales is covered as fully as possible.

- Statutory Conservation Agency and RSPB Breeding Bird Surveys (SCARABBS): This comprises a rolling series of periodic surveys (at either 3, 6 or 12 year intervals) of UK selected rare/scarce species or those that require special field methods of recording. In recent years, surveys of Ring Ouzel (*Turdus torquatus*) (2012), Peregrine (*Falco peregrinus*) (2014), Chough (*Pyrrhocorax pyrrhocorax*) (2014) and Hen Harriers (*Circus cyaneus*) (2016) have been completed. Funding for most is from the statutory agencies and RSPB but not guaranteed on schedule and although further surveys are timetabled there are concerns over future funding.

- Other Country-Level Surveys: In addition to surveys branded as SCARABBS, government agencies or NGOs also undertake other surveys at UK or country-scale in response to their own scientific or volunteer engagement needs. In Wales, this includes BTO surveys of chats (2012 and 2013), winter thrushes (2012-14), House Martin (*Delichon urbicum*) (2015-17) and Woodcock (Scolopax rusticola) (2013).

- Heronries Census – this survey, running at the UK-level since 1928, gathers counts of active nests from as many heronries as possible each year, to monitor the populations of Grey Herons (*Ardea cinerea*), and, where found together, Little Egrets (*Egretta garzetta*) and Cormorants (*Phalacrocorax carbo*). This survey is by no means comprehensive and there are many more heronries to discover and monitor. The new online developments should make it easier to incorporate additional species.

- Garden BirdWatch –around 400 volunteers in Wales record the birds seen in their gardens on a weekly basis. Running since 1995, this survey has charted the decline of the House Sparrow (*Passer domesticus*) in England compared to increases in Wales, the rise of the Woodpigeon (*Columba palumbus*), has discovered that urban birds get up later than their rural counterparts and has alerted conservationists to the impact of an emerging disease affecting Greenfinches (*Chloris chloris*), and most recently has highlighted that the provision of bird food in gardens may be a contributory factor in the over-wintering of Blackcaps (*Sylvia atricapilla*). Run by the BTO through subscription (**https://www.bto.org/volunteer-surveys/gbw**).

- Big Garden Birdwatch – this is a one-off survey, organised by the RSPB, and is undertaken for a one-hour period in January each year since 2001 and provides a snapshot of our garden birds in winter. In 2017, 24,129 volunteers took part in Wales.

- Beached Bird Survey – An annual survey of dead birds around the UK coastline, organised by RSPB and carried out over one weekend in February every year (Stanbury 2016 .pdf online).

2. Reporting survey information

County Recorder Network (County and Welsh Bird Reports)

The network of County Bird Recorders and Bird Clubs maintains archives and produces annual reports containing systematic species list as well as papers and articles. Many have also, over a period of time, produced county or regional avifaunas (**https://birdsin.wales/counties**). Avifaunas published since 2010 cover the geographic areas of Caernarfonshire (Pritchard 2017), Ceredigion (Roderick and Davis 2010), Meirionnydd (Pritchard 2012) and Radnorshire (Jennings 2014). All these sources contain valuable insights into the changing populations of species within a certain geographic area over time.

BirdTrack

An online system (**https://www.bto.org/volunteer-surveys/birdtrack/bird-recording**) coordinated by a partnership led by BTO since 2004, has become an established means of bird recording. Birds can be recorded anywhere and at any time and is a flexible way to store and explore the individual recorder's records as well as having a much wider use for species conservation and research at local, national and even international scales. Importantly, the system can be used to record breeding evidence using Atlas breeding codes, as well as a range of other parameters of interest. The website and app both provide up-to-date feedback on what's been seen locally and further afield including internationally. Graphs of the current reporting rates for each species are available online, putting sightings into context and revealing the latest patterns across the country. Complete bird lists provide the most valuable data and are, therefore, heavily promoted. At the end of 2016 there were approximately 2,800 BirdTrack users in Wales and the numbers are growing daily. There are some notable gaps in coverage (Brecknock, Monmouth and Radnor) where promotional efforts to increase take up of BirdTrack could be targeted. BirdTrack data is available for use by County Recorders for the purposes of providing useful records for county bird reports. This take-up is not, however, universally used across Wales.

Local Environmental Records Centres (LERC)

Wales is fortunate to have LERC coverage across the whole of the country. The ideal situation is that County Recorders have access to bird records held by their LERC and for there to be a data exchange agreement. This is the case in North-east Wales but is not universal. The relationship between the County Recorders and the LERCs could be improved and this is likely to happen given time.

National Biodiversity Network (NBN)

The relationship between LERCs, County Bird Recorders and ordinary birdwatchers requires clarification. Few, if any, bird records reach the NBN via the County Bird Recorders but many consultants and some organisations do supply records direct to the NBN. Many of the organisations coordinating current monitoring provide their data, usually summarised across schemes, to the NBN but these are not yet fully incorporated and discussions continue on managing access in a manner amenable to all stakeholders. The need to make ALL records available for the purposes of conservation is the ultimate aim but has yet to be fully realised.

Rare Birds Breeding Panel (RBBP)

A UK body which collates records of rare and scarce breeding species (currently those species with fewer than 2,000 breeding pairs in UK) and produces annual trends for a subset of these species. A list of species covered by RBBP relevant to Wales is available on the WOS website (**https://birdsin.wales/rare-birds/**) and WOS encourages observers to collect and submit as much information as possible on these species. We have also indicated on this list those species considered high priority for increased effort. Improving the amount of information on these species and submission to RBBP (preferably through County Recorders) will considerably improve our knowledge of rare, scarce and rare non-native breeding species. With improved surveys and provision of information to RBBP it may become possible to generate Welsh-specific trends for some species.

3. Recommendations for future surveys and monitoring – Priorities for survey work in Wales

In an ideal world there would be adequate resources, enthusiasm and energy (and appropriate methods) to survey all bird species in Wales. Despite all of the surveys above there are many gaps in monitoring coverage and WOS Council identified the need to produce a list of species which should be prioritised for future survey effort.

This was undertaken by initially considering which species are important in Wales. Importance was defined by whether:

- Wales held more than 8.5% of the UK populations of the species (8.5% selected as the land area of Wales is approximately 8.5% of the UK land area).
- the species were considered particularly characteristic of some classic Welsh habitats (e.g. Redstart (*Phoenicurus phoenicurus*).

Once the list of Important species was derived, an assessment was made on whether the level of monitoring was considered adequate or not. The main criteria for deciding whether monitoring was adequate were:

a) Where existing surveys/monitoring were not providing sufficiently robust information (either spatially or temporally) for those species which are declining, or where trends are unclear - (primarily species listed as Red or Amber in Birds of Conservation Concern Wales 3 (BoCC W3) (Johnstone and Bladwell 2016) and especially where the assessment for Wales is based primarily on the UK position as data doesn't exist for Wales – this principally based on availability of specific Wales data within the past 6 years.
b) Species where threats affecting, or considered likely to affect, a significant percentage of the Welsh population are known and it is therefore considered that additional information would assist the development of conservation measures to address the threat.

Once this process was complete the species identified were placed into 4 priority groups:

Priority 1: Species that are classified as Red in BoCC W3, but based on assessment of UK data only, or where current data for Wales is more than 6* years old, and where a current threat to the population is identified.

Priority 2: Red-listed species where a threat to the population is identified, but where the population assessment is based on Welsh data.

Priority 3: Species that are classified as Red in BoCC W3 based on an assessment of UK data only or where current data for Wales is more than 6* years old.

Priority 4: Characteristic species of Welsh habitats.

Merlin. Photo: Tony Pope

Lesser Spotted Woodpecker. Photo: Annie Haycock.

*: this fits with the periodicity of BOCCC (every six years), Article 12 reporting (every 6 years), State of Nature (every 3 years) and SCARRABBS (3, 6 or 12 years) - so in principle, there should be new data for every update.

Note: Threat defined where there are small vulnerable populations and/or proposed development or other changes are current or where declines are thought to be continuing.

The above process produced the WOS Council priority species list. Although Priority Levels are assigned, surveys of all the species in the table are important and will be encouraged/supported by WOS.

Priority -Level 1	**Priority -Level 2**	**Priority -Level 3**	**Priority -Level 4**
Species classified as Red in BoCCW3, based on assessment of UK data only, or where current data for Wales is more than 6* years old, and where a current threat to the population is identified	Red-listed species in BoCCW3 where a threat to the population is identified, with population assessment based on Welsh data	Species that are classified as Red in BoCCW3 based on an assessment of UK data only or where current data for Wales is more than 6* years old	Characteristic species of Welsh habitats
UK data used: Lesser Spotted Woodpecker **Info > 6 years old:** Merlin	Currently no species are identified at this level, but it may be required for future revisions	**UK data used:** Common Sandpiper (*Actitis hyopleucos*) Grasshopper Warbler (*Locustella naevia*) Tree Sparrow (*Passer montanus*) Yellow Wagtail (*Motacilla flava*) **Info > 6 years old:** Golden Plover (*Pluvialis apricaria*) (breeding) Lapwing (*Vanellus vanellus*) Black-headed Gull (*Chroicocephalus ridibundus*) (breeding) Short-eared Owl (*Asio flammeus*) Herring Gull (*Larus argentatus*) (breeding) Kestrel (*Falco tinnunculus*) Dunlin (*Calidris alpina*) (breeding) Water Rail (*Rallus aquaticus*) (breeding) Snipe (*Gallinago gallinago*) (lowland breeding) Redshank (*Tringa totanus*) (breeding) Spotted Flycatcher (*Muscicapa striata*) Marsh Tit (*Poecile palustris*) Willow Tit (*Poecile montana*) (breeding) Whinchat (*Saxicola rubetra*) (breeding)	Pied Flycatcher (*Ficedula hypoleuca*) Wood Warbler (*Phylloscopus sibilatrix*) Tree Pipit (*Anthus trivialis*) Redstart Hawfinch (*Coccothraustes coccothraustes*) (breeding) Species adequately covered by existing schemes/effort: Manx Shearwater (*Puffinus puffinus*) Gannet (*Morus bassanus*) Kittiwake (*Rissa tridactyla*)

4. Monitoring Approach

It is unlikely that a Wales-wide survey will be practical for most species and therefore the outline monitoring proposals made relate to surveys that use a sampling approach, and where possible building on previous surveys in defined geographical locations (e.g. previous nature reserve monitoring, local Atlas work). Broader geographic interpretation will be greatly aided by standardising methods as much as possible, informed by all relevant studies of methodologies for the target species. A key aspect of this will be to have effective collation of results from these surveys which will then provide population level or range information for species and increase our knowledge and confidence in describing changes occurring in Wales (see Reporting of Survey Information section). The information will also enable more regular updates on trends for a greater number of species, to enable targeting of action and assessment of its effectiveness.

Although the surveys proposed are based on single-species assessments, it would be extremely beneficial for other species to be surveyed in sites/areas if the field protocols allow or if a wider range of species were surveyed in the same area in the past (e.g. other woodland birds where Pied Flycatchers were the main focus).

We propose a combination of supporting existing local site based surveys, encouraging additional site or area based surveys and centralised collation of results. Baseline data for selecting sites from past/current surveys are available from such sources as:

- National Nature Reserves (NNR).
- Sites of Special Scientific Interest (SSSI)/Special Protection Areas (SPA).
- RSPB Reserves.
- Wildlife Trust Reserves.
- Other nature reserves.
- Surveys for development applications.
- Local Atlas.
- Specific surveys/projects with appropriate communication with relevant stakeholders. Examples include the BTO/RSPB Repeat Woodland Bird Survey, the Repeat Upland Bird Survey, RSPB river surveys on the Wye. Identification of available historical datasets may require further consultation.

To help facilitate this additional effort, WOS will continue to promote and/or support ongoing and periodic surveys mainly at the whole-Wales level, but will also actively encourage new initiatives through assistance with survey design, provision of baseline data and financial support, using WOS grants. This financial support could include contributions towards fieldwork, baseline data “extraction/presentation”, survey form preparation, co-ordination of surveys by volunteers or survey data collation.

On the WOS website details of suggested specific survey methods can be found. An example of this for Lesser Spotted Woodpecker is presented below.

Lesser Spotted Woodpecker	Breeding season survey
Priority:	Level 1
Survey Methods:	**http://www.rbbp.org.uk/downloads/sp_guidelines_lesser_spotted_woodpecker.pdf**
Scope:	1. Repeat of area based surveys with past data (e.g. RSPB Mawddach Valley Reserve) 2. Tetrad/10km level population estimates to be obtained in a number of squares (to be defined, based on the Atlas, which are currently occupied with stable/increasing trends, others that are currently occupied but with declining trend and thirdly those where populations recently lost Single or multiple site/square coverage. Baseline data may be available
Use:	Improve understanding of site/area based trends and, depending on number completed, enable a better assessment of trends in Wales and reduce dependency on UK trend only statements
WOS Funding	Fieldwork

Although this paper is primarily focused on improving the availability of bird data for determining population trends there are other single-species projects or demographic rate monitoring undertaken in Wales. This is highlighted and examples are listed below, but see the WOS website for a more complete list and further information, as they will all benefit from additional support and are used to improve our understanding of birds in Wales.

Monitoring Demographic Factors

There are national annual bird monitoring schemes operating that collect demographic data (breeding success, survival, etc) for a subset of species for which sufficient information is gathered. These data are used to identify significant changes in demographic rates that may have impacts on populations (such as increased nest failure) and are used in Integrated Population Modelling to determine the critical stages in the life cycle of species driving population change.

- Nest Record Scheme (NRS) – Running for more than 75 years, the NRS, organised by the BTO, gathers vital information on the breeding success of the UK's birds by asking volunteers to find and follow the progress of individual bird's nests and submit their season's recording to the BTO for inclusion in UK analyses. Due to insufficient information, these are not routinely undertaken at the country (Wales) level but this is feasible for some widespread species. In the last two years 89 people have been considered to be active nest recorders in Wales.

- General Ringing – the Ringing Scheme is run by the BTO and has been in operation for decades. In 2017 there were 153 ringers (61 A permits, 58 C permits and 34 trainees) in Wales. Ringing is a UK Government licensed activity and ringing demands a high degree of time commitment. It can take up to two years to train to get a ringing licence. However, the value of fitting uniquely numbered rings to birds is enormous. This enables individual birds to be followed through their lives. Traditionally, the aim of ringing was to understand more about migration but data are increasingly used to calculate survival rates which help in identifying factors driving population declines (Redfern and Clark et al. 2001).

- Constant Effort Site Ringing (CES) – is the first national standardised ringing programme within the BTO's Ringing Scheme and has been running since 1983. Ringers operate the same nets in the same locations over the same time period at regular intervals during the breeding season at over 130 sites in Britain and Ireland. There are 10 CES sites in Wales: (1-Anglesey, 3-Pembrokeshire, 1-Flintshire, 1-Glamorgan, 1-Caernafonshire and 1-Powys). The Scheme provides valuable trend information on abundance of adults and juveniles, productivity and also adult survival of 24 species of common songbird.

- Retrapping Adults for Survival (RAS) – this standardised ringing programme has been running since 1999. Ringers aim to catch or re-sight at least 50 adult birds of a single species in a study area during the breeding season. The study area is well defined and the ringer is aiming to find the vast majority of adults. There are 29 RAS studies in Wales covering the following species: Arctic Tern (*Sterna paradisea*), Common Tern (*Sterna hirundo*), Dipper (*Cinclus cinclus*), Hawfinch, House Sparrow, Kittiwake, Lesser Black-backed Gull (*Larus fuscus*), Pied Flycatcher, Razorbill (*Alca torda*), Reed Bunting (*Emberiza schoeniclus*), Reed Warbler (*Acrocephalus scirpaceus*), Sedge Warbler (*Acrocephalus schoenobaenus*), Shag (*Phalacrocorax aristotelis*), Siskin (*Carduelis spinus*), Swallow (*Hirundo rustica*) and Wheatear (*Oenanthe oenanthe*).

Species/Area Specific Monitoring Projects

Colour-ringing Projects

All colour-ringing sightings (or other rings) should be reported to **www.ring.ac** but WOS would encourage observers to make extra efforts for the species identified as Priority species. A list of relevant projects can be found on the WOS website. An example of the information on the WOS website is given below:

Twite (*Carduelis flavirostris*): Twite are currently being caught and ringed in their main and possibly only Welsh breeding site at Nant Ffrancon in Snowdonia. Overwintering birds on the north Wales coast, particularly at Connah's Quay Nature Reserve (Dee Estuary) have been ringed since 2014. Movements between Wales and the breeding grounds on the west coast of Scotland have now been shown.

5. Getting Involved

How you can help

- Contribute to an ongoing monitoring scheme such as BBS, WeBS etc.
- Contribute to special, periodic and one-off surveys according to interest and the geographical scope.
- Aim for BirdTrack recording of ALL Red List species, and strive to provide complete lists, as these are one of the most valuable metrics that we can use from BirdTrack.
- Submit breeding evidence to BirdTrack, especially for RBBP species.
- Survey organisation.
- Fieldwork.
- Data collation.
- Contributing and publishing the information/data already collected.
- Reporting sightings of colour-ringed birds.

How local bird clubs can help

- Encourage participation, support and promote coverage.

How can WOS help you?

WOS aims to work with all bird clubs across Wales to raise the profile and promote and support surveys currently underway by the whole range of organisations involved. It also aims to encourage groups to organise, implement and publish targeted survey work. WOS grants will be targeted towards species/projects that are focused on the priority species identified in this paper, through funding:

- Fieldwork.
- Baseline data "extraction/presentation".
- Survey form preparation.
- Co-ordination of surveys by volunteers.
- Survey result data collation.
- Context to bird monitoring in Wales through an updated survey meta-data file.

WOS will also provide, where required, assistance with survey design, provision of baseline data, meta-data and contacts of data-owners.

In promoting increased involvement in monitoring in Wales, WOS is keen to ensure that the recognised bodies for validating records (e.g. Welsh Records Panel (WRP), British Birds Rarities Committee (BBRC) and County Rare/Scarce Bird Panels), existing organisers/coordinators (e.g., South Wales Peregrine Group) and legal requirements (e.g. Schedule 1 licences) and best practice (e.g. landowner permission and feedback) are acknowledged, as these are all essential in ensuring smooth collection and use of the bird database in Wales. In addition, WOS supports all the appropriate organisations and individuals which collate/publish information and would urge these to integrate their databases/archives as much as possible.

We hope that this paper will engender further discussion, the collation of existing detailed surveys/studies of Welsh birds as yet unpublished (using the WOS website pages dedicated to identifying such studies) and future surveys and studies of the species considered to be a priority in Wales.

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The Welsh List: A Checklist of Birds of Wales (1st Edition)

R.I. Thorpe and A. Stratford
Bryn Llus, Rhostryfan, Caernarfon, Gwynedd LL54 7PF

Crynodeb

Mae'r papur yma'n cyflwyno'r argraffiad cyntaf o'r Rhestr o Adar Cymru. Gellir gweld y rhestr lawn ar safle we Cymdeithas Adarydda Cymru.

Summary

This paper introduces the first edition of the Checklist of Birds of Wales. The full list is available on the Welsh Ornithological Society website.

Introduction

This is the first edition of the Checklist of Birds of Wales, hereafter referred to as the Welsh List, and has been prepared as a statement of the status of those species that are known to have occurred in Wales and the surrounding seas (up to 12 nautical miles). It incorporates all records up to 31st December 2016. These were extracted from Lovegrove et al (1994), Green (2002) and subsequent records detailed in the Welsh Bird Reports (WOS).

The Welsh List

The Welsh List is the list of birds recorded in Wales maintained by the Welsh Ornithological Society (WOS) through the Welsh Records Panel (WRP). However, records have only been included after acceptance by the British Ornithologists' Union Records Committee (BOURC) and/or the British Birds Rarities Committee (BBRC).

The Welsh List (1st Edition) can be viewed on the WOS website (**https://birdsin.wales**). For each species, the list includes the English vernacular name, Welsh name and scientific name and each is assigned to a Species Category and Species Status (see below).

It is intended that the Welsh List will be under regular review by the WRP, with new species added, and potentially some removed following re-assessment. There are a few issues to resolve over the racial identity of some species, but these do not impact on the assignment of species to categories. A BOURC announcement that "From 1 January 2018 the British Ornithologists' Union (BOU) will adopt the International Ornithological Congress (IOC) World Bird List for all its taxonomic needs" will result in a full revision of the Welsh list in due course.

Taxonomy, English and Welsh names

In maintaining the Welsh List, the WRP relies on the BOURC for all decisions regarding taxonomic and English name issues. Welsh names follow those used in the Welsh Bird Report, but there remains an issue regarding whether Welsh vernacular names for all races are required – this will be addressed in updates of this list on the WOS website.

Species categories used in the Welsh List

Each species is categorised according to the criteria for its admission to the Welsh List, with the Category (A, B or C) appearing to the right of the Welsh name in the checklist. A few species are assigned more than one category. Categories D and E do not form part of the main list, but are included in the checklist, although currently there are no species in Category D. It is acknowledged that Category E is likely to be incomplete as few observers report 'obvious' escapes. Where category A, B or C species are known to have occurred also as escapes, this is indicated in this checklist.

As with taxonomy and English names, the Welsh List follows BOURC guidance on category definitions, except for C5 which has been expanded to include other parts of the UK as well as 'abroad' and, to add to the understanding of species in category C1, a subdivision has been made (see below).

The categories used in the Welsh List are defined as follows:

A Species that have been recorded in Wales in an apparently natural state at least once since 1st January 1950.

B Species that were recorded in Wales in an apparently natural state at least once between 1st January 1800 and 31st December 1949, but have not been recorded subsequently.

C Species that, although introduced in Wales, now derive from the resulting self-sustaining populations:

C1.1 Naturalised introduced species – species that occurred only as a result of introduction PRIOR to 1950 e.g. Red-legged Partridge (*Alectoris rufa*).

C1.2 Naturalised introduced species – species that occurred only as a result of introduction SINCE 1950 e.g. Mandarin Duck (*Aix galericulata*).

C2 Naturalised established species – species with established populations resulting from introductions by man, but which also occur in an apparently natural state e.g. Gadwall (*Anas strepera*).

C3 Naturalised re-established species – species with populations successfully re-established by Man in areas of former occurrence e.g. Goshawk (*Accipter gentilis*).

C4 Naturalised feral species – domesticated species with populations established in the wild e.g. Rock Dove/Feral Pigeon (*Columba livia*).

C5 Naturalised species – species from established naturalised populations in other parts of Great Britain or abroad.

C6 Former naturalised species – species formerly placed in C1 whose naturalised populations are either no longer self-sustaining or are considered extinct e.g. Golden Pheasant (*Chrysolophus pictus*).

D Species that would otherwise appear in Category A except that there is reasonable doubt that they have ever occurred in a natural state in Wales. Species placed in Category D only form no part of the Welsh list and are not included in the species totals.

E Species that have been recorded in Wales as introductions, human-assisted transportees or escapes from captivity, and whose breeding populations (if any) are thought not to be self-sustaining. Category E species form no part of the Welsh list (unless otherwise included in Categories A, B or C).

E* Species in Category E that have bred in the wild in Wales (whose breeding populations are thought not to be self-sustaining) e.g. Reeves Pheasant (*Syrmaticus reevesii*)

A species is usually placed in only one category, but some are placed in multiple categories. Status definitions used in the Welsh List as follows:

Resident and breeds	Present all year and breeds
Breeds, but winters outside of Wales	Breeding summer visitor
Resident but not breeding	Present all year, but not breeding
Regular breeder before 1950	
Regular breeder for a period after 1950	
Occasional breeder before 1950	Bred on fewer than 5 occasions
Occasional breeder after 1950	Bred on fewer than 5 occasions
Introduced before 1950	Introduced resident breeder
Introduced since1950	Introduced resident breeder
Bred, but in hybrid pairing	
Winter migrant	Present during winter months
Passage visitor	Spring and autumn passage migrant
Scarce migrant	Scarce visitor (not on BBRC or Welsh Records Panel lists), with 5-20 records each year
Rare migrant	Rare visitor (majority assessed by Welsh Records Panel, but not on BBRC list), with more than 10 occurrences ever, but fewer than 5 records each year
Vagrant	Vagrant to Wales (assessed by British Birds Records Committee or Welsh Records Panel) with 10 or fewer records in total
Escape	Escapes from captive populations
From re-introduction scheme	Marked birds attributable to re-introduction schemes (eg Crane (*Grus grus*))

The Welsh List

The number of species recorded in Wales (as of 31st December 2016), within each category, is as follows:

Category	Total
A	430
B	7
C	11
Total	**448**

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Book Review

Birds of Caernarfonshire by Rhion Pritchard

This, the author's second county avifauna to be published by the Cambrian Ornithological Society in recent years, follows the format of his companion volume Birds of Meirionnydd (2012). Ideally, it should be read in conjunction with the breeding distribution maps shown in our latest regional atlas The Breeding Birds of North Wales (2013). Together, these three works provide a timely assessment, or stock-taking exercise, of the wealth of bird life still to be found in mainland Gwynedd despite increasing environmental problems. A quick browse shows that some 390 species have been recorded in Caernarfonshire, excluding feral wildfowl and escaped exotics - a high count for a moderate sized county. About 115 (30%) are resident/migrant species breeding each year; and 55 (15%) are annual winter visitors or passage migrants. The majority are either irregular/occasional visitors (25%) or vagrants/rarities (33%), many of these on Bardsey.

The attractive cover illustration of this 291 page soft-back book is a Philip Snow painting of Choughs on a Llŷn cliff top with Bardsey across the sound. Introductory sections outline the geology, topography and (all too briefly) climate. There are, however, very useful descriptions, with 16 colour photographs, of the main habitat types. There follows an interesting historical account of bird recording in the county but only a few lines on the important topic of detrimental effects of recent agricultural changes on bird habitats and breeding populations. The book ends with a comprehensive reference list (8 pages) and a useful gazetteer of some 275 localities.

The body of the book comprises the Species Accounts, and the discerning reader will not be disappointed by the mass of data analysed and presented in a clear style. For each breeding species information has been obtained from various recent county, national and COS member studies; and then collated to provide a comprehensive summary of its present status with respect to: habitats, movements, distribution, history and trends in abundance, present status and prospects. Breeding population estimates are also given for many species though often with caveats as to reliability. The key sites for wintering wildfowl and waders are identified while charts show any changes in their abundance over the last 30 years. All the records of scarce and rare species are listed in easy-to-read tables.

This book is a timely and significant contribution to Welsh ornithology and essential reading both for keen birders and for professional conservationists who may wish to know how particular species are faring in these challenging times. It is excellent value at such a low price (£12).

Peter Dare

WOS members can purchase copies for £10 + £2.00 postage. Send your cheque payable to "Cambrian Ornithological Society" to Rhion Pritchard at: Pant Afonig, Hafod Lane, Bangor LL57 4BU. Non-members £12.00 + £2.00 postage.

Lapwing. Photo: Bob Garrett.